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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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The Birmingham Conference.

The Birmingham Conference Committee are to be congratulated on the excellent programme that has already been arranged for the members of the Institution of British Foundrymen and their ladies, and there is every reason to believe that it will be a record meeting. Bearing this in mind, the committee, having assured themselves that most of the hotel accommodation has already been taken, have arranged to take over 500 houses. A list has been prepared, and members should make early application to Mr. Thos. Vickers, the Conference Secretary, at Central House, New Street, Birmingham. Additionally, those requiring hotel accommodation should also write Mr. Vickers, as his committee have still a few rooms left in the principal hotels.

Every member attending the Conference will be presented with a souvenir booklet describing the various local details and the full programme of the Conference. They will also receive an official Conference badge.

Whilst the Conference officially opens on June 21 and closes on June 24, arrangements have been made for the entertainment and enlightenment of members the two previous days. On Monday, June 19, there is to be a Foundry Trade Exhibition lunch at the Grand Hotel, organised by the various Rotary Clubs of the Midlands. Lord Weir is to preside, and members of the Institution are invited to attend. The tickets are priced at 4s. each.

On Tuesday, June 20, H.R.H. the Duke of York will visit the exhibition. During the afternoon the competitions and cinema lectures will be in full swing. For the ladies who have already arrived for the Conference an evening drive to Cannon Hill Park has been arranged. As is customary, a General Council meeting will be held in the evening.

Wednesday sees the opening of the Conference, when the visitors will be welcomed by the Lord Mayor (Ald. David Davis) and gentlemen representing the local technical societies. The ladies are to be shown round the Art Gallery under the guidance of Sir Whitworth Wallis. The afternoon will be devoted to the official visit to the exhibition.

The ladies are invited to lunch by the Committee at the Grand Hotel, and will spend the afternoon visiting Messrs. Cadbury's works at Bournville, where tea will be provided, and afterwards the Committee will motor them to Great Malvern. This leaves the members free to attend the Institution Banquet, which is to cost 10s. 6d.

On Thursday morning the Conference will be resumed, during which time the ladies will visit Messrs. Elkington's silver-plate works. In the afternoon the visitors are invited by the Lord Mayor to a garden party. Friday morning is, as usual, to be devoted to sight-seeing, the arrangements being that all members are invited by Messrs. W. & T. Avery to visit their works, where the testing of materials will be the chief item to be investigated. The Committee are inviting the visitors to lunch with them at the Grand Hotel. After lunch an excursion to Warwick, Stratford, and Leamington (where tea will be taken) has been arranged for. The charge for this has still to be ascertained.

On Saturday, June 24, the closing day of the Conference, the exhibition will be re-visited, and opportunity will be taken of the occasion to present the awards to the winners of the competitions by the Lord Mayor.

The Papers to be presented are of an exceedingly interesting character. About a dozen are to be read, including those from representatives of the French, Belgian, and American Foundrymen's Associations. We hope to publish full details of these in our next issue.

It will thus be seen that an excellent programme has been arranged, and although we previously raised the point that it would be desirable for the whole of the members to be present to welcome his Royal Highness, it is now apparent that it would be difficult to re-arrange a programme on which, obviously, an enormous amount of time and trouble has been expended. Now that the Conference Committee have done so much for the social welfare of the members, it is up to the 1,800 adherents of the Institution to support them by taking full advantage of all the splendid arrangements that have been made.

THE PARTNERSHIP heretofore subsisting between Messrs. S. Stanley, J. Bayley and A. G. C. Davies, carrying on business at Hall Street, Wolverhampton, as the Wolverhampton Tool and Presswork Company, has been dissolved.

The Welding of Foundry Products and Plant.

By C. W. Brett,
Managing Director, Barimar, Limited.

In the past little or no attempt was made to reclaim units or components discovered to be unserviceable. A casting was good or bad according to the condition it was in when taken from the mould

In drawing attention to this we are not, of course, criticising the attitude of foundry-owners to improvements in the actual process of fabrication. Our remarks are aimed at those who fail to realise the possibility of making good after failure, or who do not appreciate the fact that all plant and machinery constructed of any of the industrial metals is capable of being entirely restored to full service, when, through fracture, wear and tear, or other reasons, it is disabled and out of commission.

Now when any product, or producing unit, used in the metal trade is found to be defective or unserviceable, many men are of opinion that the scrap-heap is the only suitable place for it; since, on the one hand, the casting is evidently unsound, and, on the other, the machine is worn out. A colossal loss is annually incurred in this way through the assumption that, short of replacement, no reliable method of metallic reconstruction exists. Such an impression, of course, is erroneous.

Actually something like 50 per cent. of the contents of the average scrap-heap can be rapidly, economically, and permanently rendered equal to new by the skilful application of one or other of the half-dozen welding processes.

Irrespective of the nature of the faults discovered, over 75 per cent. of defective castings can be repaired in such a manner as shall preserve their intended utility. Any reputable firm of welding specialists can, under definite guarantee, undertake the restoration of members composed of cast iron, wrought iron, steel, alloy steel, aluminium, bronze, or gunmetal.

Any doubts which may exist in the minds of foundry-owners will be quickly dispelled by a perusal of the tests advocated by the recently inaugurated American Bureau of Standards (Welding), which prove conclusively that, in competent hands, repairs effected by autogenous fusion will yield 100 per cent. efficiency.

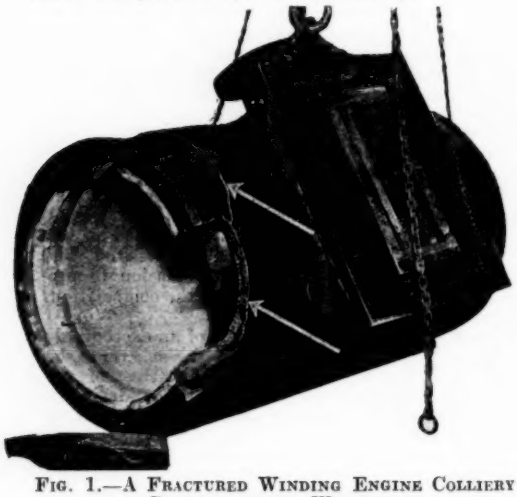

Fig. 1.—A Fractured Winding Engine Colliery Cylinder before Welding.

In this connection, however, it should be pointed out that welding embraces several distinct processes, each having its specific use, and no welding concern can hope successfully to undertake general repairs—either to foundry products or plant—by the employment of only one process. Unfortunately for the prestige and progress of welding, this idea is too common, and is shared by many who are actually engaged in welding practice, with the inevitable result that the popularity and employment of welding is restricted. Under no circumstances can an unsuitable process produce a sound, efficient, and wholly satisfactory job.

Examples of highly efficient work, done by skilled operators employing the right process, could be given without limit; but perhaps two cases recently dealt with will serve to indicate the scope and utility of this method of metallic reconstruction.

The first concerns the cast-iron frame of a punching and shearing machine, from which the table had been completely broken off. A new casting would have been extremely expensive, and would have entailed long delay before delivery—which, of course, meant that the unit would have been idle during many days, if not weeks.

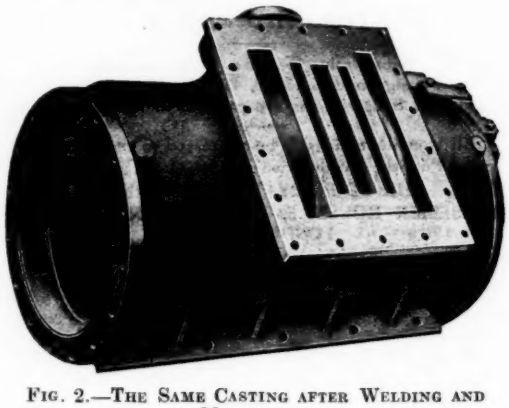

Fig. 2.—The Same Casting after Welding and Machining.

Inspection showed that metal 4½ in. × 16½ in. had been fractured, and minor damage to other portions sustained. As the machine was required to stand very heavy work, the repair had to be an exceedingly strong one. A system applicable to cast-iron welding was employed, and suitable laboratory, workshop, and working tests were applied before the firm were satisfied that the unit could be despatched. The work occupied sixty hours, and was undertaken under definite guarantee. The saving to the owners in this case was considerable. The machine has now been in service for some time, and has proved itself equal to every demand.

Another job has reference to the cylinder of a pit-winding engine, shown in Figs. 1 and 2, which, under exceptional circumstances, gave out at a very critical juncture.

The total weight of the cylinder was approximately 3½ tons, length 5 ft., and bore 26 in. The damage consisted of cracks and fractures, which extended through flange and exhaust port at the one end, and for a considerable distance down the bore at the other end. The thicknes of the metal involved varied from 1½ in. to 3 in. The steam pressure normally carried by this cylinder is about 80 lbs. to the sq. in. The cost of replacement and the length of time required for delivery was a serious matter for the owners, who feared a shutdown for a long period.

It was decided, therefore, to try welding. The job, though it required careful handling and special treatment, was completed in a few days—including machining the bore and other portions—and tested to a pressure of 160 lbs. to the sq. in. before despatch. The work was undertaken under guarantee, and has since been working continuously without the slightest trouble.

Amongst the machines used in the foundry and kindred trades which have been reconstructed by the employment of common-sense welding are:—Core and mould-drying oven fittings, muffles, electric crucibles, moulding machines, boxes and ladles, steam hammers, shears, saws, hydraulic presses, borers, drillers, cranes, overhead gear, fans, sand-mixers, weighing machines, and all descriptions of inter-departmental or road transport.

The Department of Overseas Trade intimates that H.M. Trade Commissioner at Toronto (Mr. F. W. Field) has received an inquiry from a firm in Ontario desirous of securing quotations from U.K. manufacturers for 16,000 ft. (1,200 tons) of cast-iron pipes, either bell and spigot or flanged, 12 in. in diameter, to stand 100 ft. head pressure. Particulars are to be obtained from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

The Blast Furnace and the Foundry Cupola.*

By J. E. Fletcher, M.I.Mech.E., M.Inst.Met. (Past President), Director of Research, British Cast Iron Research Association (pro tem.).

Wherever good carbonaceous fuel is economically available in close proximity to smelting or remelting furnaces it is almost axiomatic that these processes are most economical wherein the ores to be smelted or the metals to be remelted are heated in direct contact with the fuel used. The three most economical furnaces for the smelting, melting and refining of iron belong to this type, wherein the fuel and its necessary oxygen are in contact with ore and metal. All three are pneumatic, working with airblast under pressure, and though it is possible that electric means may triumph where the power cost per ton of ore smelted or metal remelted or refined is lower than the available carbonaceous fuel cost—in the case of extraordinarily cheap water power, be it waterfall or tidal—the present coke-fired blast furnace or cupola seems likely to remain without serious competition for many years to come. The Bessemer converter—which is merely an addendum to the cupola, with further air under pressure—as the refining agent, is yet without a competitor in the matter of fuel cost per calory supplied or per unit of metal remelted and refined. It has yet to be proved that the use of powdered fuel or oil for the supply of the necessary heat and reducing gases in long rotating furnaces of the "Basset" or cement-kiln type will be able to produce direct-melted spongy iron, steel or cast iron more economically than is possible in the blast furnace, cupola and converter.

In the iron foundry industry the products of the blast furnace and cupola are at once of first importance, the principal object of the foundryman being to procure metal of suitably homogeneous character which, when poured into perfectly made moulds, shall produce perfect castings Assuming that the designing, moulding, gating and feeding of a casting are questions somewhat apart from the metal production problem, though allied to it, it is to the preparation of cast iron for foundry needs that attention is specially drawn in this paper.

There is little doubt that in the two blast furnaces with which we are concerned, namely, the large smelting furnace and the smaller remelting furnace or cupola, we have the cheapest forms of smelting and remelting apparatus. The difficulty is that when critically examined these two types of furnaces are, as far as affects the quality of the products, of low efficiency. Many of the foundrymen's troubles originate in this indisputable fact, and it is sought to compare some of the fundamental difficulties in the blast furnace and cupola with a view to the partial elimination of such troubles, or as pointing the way to the production of more uniformly suitable cast iron for foundry work.

The Blast Furnace.

In an ideal blast furnace operated so as to produce iron of uniform composition, the ores, fuels and fluxes used would be of regular character with respect to physical, chemical and mineralogical composition, uniformly charged at the correct rate. The air blast would be regular in volume, moisture content, temperature and pressure and so blown into the furnace that all parts of the fusion zone would be equally supplied with the necessary air. The air supply would be such as to meet correctly the needs of the fuel combustion, and to yield the exact volume of gases of suitable analysis to promote regular reduction of the ores. The temperature of the fusion zone, furnace shaft, and of the hearth, would be, by such scientifically correct proportion of fuel to blast, suitable for the formation and fusion of the alloying slags, for the carburisation of the descending iron, and for the retention of the metal in the ideally liquid condition in the hearth. And finally, the remelted metal should be retained in the hearth sufficiently long, and no longer, for perfect diffusion to take place; the metal being then run into moulds of such proportions and materials as would retain a homogeneous chemical and physical structure in the pigs produced. In addition to the foregoing conditions for ideal operation it will be clear that there must be a certain rate of working in any given size of furnace in order to obtain ideal conditions for iron oxide reduction, iron carburisation, and for the formation of the alloying slags and their proper functioning. There would further be no heat-radiation losses or wall friction such as would tend to produce any irregularity in burden descent, reduction of iron oxides, or in the ascent of the heating and reducing gases. It is in the departure from the ideal conditions as outlined in the foregoing that the iron smelter finds his difficulties in producing at a regular rate homogeneous metal of desired composition. The ores especially are of differing chemical, mineralogical and physical composition. The mixture of large lumps and "fines" brings about, in any layer of ore burden, areas of differing density and porosity. In the descent into the reducing zone the pressure of the burden above reduces this gas porosity and, in furnaces of the usual form, as the burden descends the outer ring next to the walls opens out and such annular zone becomes more permeable to the gas flow and tends to promote a higher gas velocity adjacent to the shaft wall with a correspondingly lower one in the axial zone. Such irregular gas porosity across the entire burden section obviously tends to irregular speeds of iron reduction and to non-homogeneity in the composition of the gases rising through any horizon. The same physical difficulties occur with the coke, which, differing in porosity, size of lumps, and ash content, hinders the attainment of uniform gas conditions in the fusion zone. The fact that it is practically impossible to attain to the theoretical condition of a homogeneous distribution of blast in the fusion zone intensifies the gas trouble. Each tuyere distributes its blast irregularly, the greatest penetration effect occurring immediately opposite the nose, and there must be, therefore, if the total blast supply is correct in volume, zones where the air supply is excessive, and others where it is insufficient. This means, as Heyn has shown, considerable iron oxidation in the zone immediately in front of each tuyere, and it is not unlikely that the drops of metal falling into such zone become oxidised much as overblown Bessemer metal is oxidised.

It is not difficult to conceive that in high furnaces, rapidly operated and using necessarily high blast-pressure, the oxidising effect on a portion of the metal must be considerable, and it is not likely that all such iron oxide enters and remains in the slags. Probably most of it finds its way into the metal. The tuyere blast streams, seeking the easiest upward path, produce, after union with the carbon of the coke, far from regularly distributed gas currents. These streams, of differing velocity and composition, act at different velocities in their carburising effect on the descending iron and must tend to the production of streams of varicomposed iron far from uniform in carbon content.

As the hearth is more or less filled with coke the diffusion of the variable metals in the well of the furnace must be difficult, and the alloying of silicon and manganese is conceivably very far from being homogeneous. We are not on sound ground in assuming that diffusion is an instantaneous process. Actually it is far from being so when considering such masses as are present in the hearth of the blast furnace. Again, in hot blast furnaces, the variation in the temperature of the blast, between stove reversals or changes, means that the volume of air passing into the furnace is constantly varying, when the blower or blowing engine is supplying air at constant pressure and speed. Hence the penetration effect of the blast varies, and during such variations there must necessarily be a series of fluctuations in melting speeds producing metals of different carbon content. This variable action due to variation in air temperatures during stove reversals or changes is much more serious than may appear at first sight. Thus in blast temperatures varying from 705 deg. to 480 deg. C., at every change of stoves the air volume blown per minute into the furnace at the higher temperature is about 30 per cent.

* A Paper read before the Staffordshire Iron and Steel Institute on March 25.

greater than at the lower. The smaller penetration effect of the hotter blast and its promotion of a higher temperature in the outer ring of the fusion zone tends to quicker reduction and a more silicious iron than is produced when the blast has fallen in temperature. In the case of a furnace working at such speed that three strata of burden are fused during one stove change period, followed immediately by tapping, the chances of perfect diffusion of the different grades of iron produced in the hearth are remote. Hence the variation in the silicon variation in a single bed of pig iron traceable to such actions.

Cold Blast Furnaces.

The small cold blast operated furnaces casting once or twice a day approximately much more closely to ideal conditions, the rate of smelting being slow, and the opportunities for metal diffusion in the hearth great. In addition to such quality advantages there is the fact that almost constant temperature prevails in the hearth by reason of the regular supply of cold air at constant temperature, volume and pressure. Moreover, it is possible more uniformly to spread the burden in small slow-running furnaces and the vertical pressure of the furnace materials in, say, pounds per square foot of hearth area at the tuyere level is less. The demand for high blast-penetration velocities is absent in small cold-blast furnaces and the air diffusion through the burden must be much more perfect than can be the case in modern rapidly-driven furnaces. It will be recognised on carefully considering the difference between large hot-blast high-output furnaces and small slowly running cold-blast furnaces that the latter work under conditions more nearly approximating to the ideal than do the former.

Again, the use of high-pressure and high-temperature blast tends to rapid carburization of the metal. During the stove temperature variations and the accompanying variations in blast temperature the carbon content of the metal reaching the hearth fluctuates between the hyper-eutectic and hypo-eutectic values. If the speed taken by the burden in its descent through the carburization zone is slow, and the temperature of the gases and burden higher than 1,130 deg. C., during the descent through the boshes, then the iron reaching the tuyere zone will be eutectic or hyper-eutectic (4.3 per cent. carbon or over). On the other hand, slow descent of the burden into a cooler bosh zone leads to hypo-eutectic iron in the tuyere zone (below 4.3 per cent. carbon).

If the reduced spongy iron arriving at the top of the boshes (where the usual temperature in modern furnaces is about 1,100 to 1,150 deg. C.) has become carburized to say 4.3 per cent. fusion takes place there, and the metal rapidly finds its way to the hearth. On its way the liquid trickling streams of metal pass the tuyere zone and there, undoubtedly, a portion is oxidized; the stronger the blast jets across which the streams travel the more serious must be the oxidization.

In the old cold-blast furnaces the cold soft blast at low velocities obviously had less oxidizing effect than has the high velocity hot tuyere jets in modern furnaces. It is possible in cold or cool-blast furnaces of small size so to proportion the fuel ratio (ore and coke) that the spongy reduced iron arrives in the fusion zone with a low carbon content (say 3.0 to 3.5 per cent.) and melting there, flows down into the hearth, the resulting iron being of low carbon type.

Such a procedure is practically impossible in a hot-blast rapidly driven furnace, wherein, owing to the height of the stock column and the comparatively high temperature of the burden the carburization up to the eutectic point is reached by the time it reaches that horizon corresponding to the eutectic fusion temperature.

From analyses it is easy to see that most modern hot blast foundry irons are really hyper-eutectic, for each percentage of silicon corresponds to a carbon loss by the original metal in the hearth of 0.286 per cent., and each percentage of phosphorus to a loss of 0.387 per cent., as will be shown later. Manganese affects the carbon content but little unless in excess of, say, 1 per cent., when the added carbon due to manganese is in the order of 0.018 per cent. for each per cent. of manganese. Taking the sulphur present in cast iron as neutralized by manganese, the added carbon in terms of manganese and sulphur is = 0.018 per cent. (Mn = 1.8 per cent. S). The total carbon content of a pig iron can be compared with the eutectic content by means of the expression: Total carbon = 4.3 — 0.286 Si per cent. — 0.387 P per cent. + 0.018 (Mn per cent. — 1.8 S per cent.). A grey iron of actual analysis: Total carbon, 3.50; silicon, 1.50; manganese, 0.55; phosphorus, 1.10; and sulphur, 0.10 per cent.; is hyper-eutectic, the estimated eutectic carbon content being 3.354 per cent. Here the excess carbon above eutectic requirements is 0.146 per cent.

Foundry pig irons of hot blast type are rarely hypo-eutectic as the following table shows:—

TABLE I.—*Showing the Composition of Pig-irons in Relation to the Eutectic Demands.*

	% Mn.	% Si.	% P.	% S.	% T.C.	% T.C. eutectic needs	Eutectic demands Over. +	Eutectic demands Under. —
Foundry ...	0.30	3.57	1.550	0.005	3.28	2.68	0.60	—
Basic ...	1.65	1.20	1.690	0.058	3.00	3.33	—	0.33
Basic ...	1.38	2.03	2.310	0.097	2.40	2.85	—	0.35
Basic ...	1.90	0.90	2.100	0.080	3.50	3.27	0.23	—
Foundry ...	0.81	3.10	1.430	0.026	3.55	2.87	0.68	—
Cleveland ...	0.60	2.25	1.400	0.080	3.50	3.11	0.39	—
Hematite ...	1.30	2.00	0.103	0.070	3.70	3.71	—	0.01
Cold blast ...	0.50	1.00	0.470	0.080	3.10	3.84	—	0.74
Foundry ...	0.80	2.85	0.320	0.030	3.62	3.36	0.26	—
Foundry ...	1.25	3.00	0.600	0.060	3.50	3.23	0.27	—
Hematite ...	0.31	2.19	0.025	0.010	3.48	3.67	—	0.19W
Hematite ...	0.17	2.65	0.202	0.005	3.91	3.54	0.37	—S
Cold blast ...	0.90	1.60	0.600	0.010	3.12	3.63	—	0.51
Cold blast ...	0.75	1.35	0.570	0.030	3.10	3.70	—	0.60
Foundry ...	0.86	2.33	1.450	0.100	3.50	3.07	0.43	—
Hematite ...	0.91	1.15	0.030	0.040	0.04	3.98	—	0.30W
Hematite ...	1.63	1.02	0.020	0.010	3.91	3.54	0.37	—S

J. E. Johnson, Junr.'s statement that high temperatures in the tuyere zone are conducive to high carbon weak irons is borne out by the author's experience, who, however, is of the opinion that the claim that oxygen in the product is beneficial requires further proof. If the oxygen present is in the dissolved ferrous oxide produced by fierce tuyere action it is not easy to accept Johnson's view unless there has been sufficient time given in the hearth for the FeO. to attack the massive graphite flakes or kish thrown out by the hyper-eutectic portions and oxidize them thus:—

$$FeO + C = Fe + CO$$

Such action once started may continue during the freezing of the metal in the pig beds.

A study of the Table No. 1 suggests the probability that cold-blast and moderate fusion-zone temperatures are the main causes of low carbon irons of the hypo-eutectic type and which are commonly recognised as giving the best results in the foundry, except in special cases where high carbon is necessary.

In the important matter which arises in the study of the total carbon effect, Mr. F. J. Cook recognised years ago the effect of silicon on total carbon content—following an earlier statement of Ledebur—and showed that excellent results for certain castings followed the recognition of the relationship between silicon and total carbon content as expressed by the formula:—

$$\frac{\text{T.C.}}{4.26 = \frac{\text{Si.}}{3.4}} = 0.6 \text{ to } 0.8$$

Thus an iron of 1.5 per cent. silicon, 0.8 per cent. phosphorus, 0.5 per cent. manganese, would—if obtained in true eutectic condition—have a total carbon content of 3.67 per cent., whereas Mr. Cook's ratio calls for 2.3 per cent. to 3.0 per cent.

The point emphasised in such a study is that total carbon content is a vital factor in judging the physical quality of cast iron as used for engineering castings of maximum toughness and soundness. The expression used by Mr. Cook should be used only in the case of irons having a phosphorus content of 0.8 to 1.0 per cent. for, as can be shown, phosphorus lowers the total carbon content of cast iron by reason of the displacement of the carbide of iron in the hearth by iron phosphide. Generally the mechanism of such displacement may be stated thus:—

Silicon and Phosphorus.

When silicon and phosphorus enter the iron in the furnace hearth through the slag, in accordance of reactions of the type:—

$$SiO_2 + 2Fe_3C = 2\,CO + Fe_2Si + 4\,Fe.$$
$$P_2O_5 + 6Fe_3C = 5\,CO + 2Fe_3P + 12\,Fe,$$

the carbon of the molten carbide Fe_3C is displaced and iron set free. The freed iron unites with silicon and phosphorus to form the silicide Fe_2Si or (FeSi + Fe) and the phosphate Fe_3P.

Thus 1 lb. of Si unites with 4 lbs. Fe to form Fe_2Si.

Thus 1 lb. of P unites with 5.42 lbs. Fe to form Fe_3P.

Also 4 lbs. of Fe requires 0.286 lb. C to form Fe_3C.

Also 5.42 lbs. Fe requires 0.387 lb. C to form Fe_3C.

Hence 0.286 per cent. carbon is displaced by 1 per cent. Si; 0.387 per cent. carbon is displaced by 1 per cent. P.

when Fe_3C is decomposed by the entrance of Si and P into the liquid hearth-iron. Wüst and Peterson proved that the addition of Si to the eutectic (4.3 per cent. C+95-7 Fe) lowered the total carbon content by about 28 per cent. for each per cent. of Si added, and Stead has stated the fact that the total carbon content in pig-iron is lowered by the presence of phosphorus. Analyses of pig-iron, of course, verify these conclusions.

How Fluctuations in Composition arise.

Now, whilst the phosphorus in the ores almost completely passes into the iron at all temperatures above the melting points of the metal in the blast-furnace hearth, it is otherwise with silicon, which is alloyed with the iron increasingly as the temperature of the hearth and its slag rises. It is here that the fluctuations in total carbon and silicon content arise, and it is not difficult to realise how easily irregularities in blast temperature influence the quality factor. Towards the end of a furnace campaign, when the lining has been badly and irregularly worn, the speed of burden descent cannot be uniform at every point of the circumference. "Slips" and "hanging" troubles occur leading to irregular zones of reduction, melting, and carburisation, with the inevitable departure from uniformity in the hearth. One section of the hearth-level may be receiving streams of hypo-eutectic metal, another of hyper-eutectic. Opposite a pair of hot-working tuyeres high-silicon iron may be produced, whilst in another part of the hearth a dull tuyere area may be producing low-silicon high-carbon metal.

Again, in a sluggishly descending portion of a burden, working down slowly past the nearest tuyeres, over-oxidation is liable to occur, and the metal running into the hearth will be charged with oxidized iron. All this points to the fact that as diffusion of the various types of metal in a large hearth cannot be perfect under any circumstances, the product of a bed of pig-iron must often be very variable in grade and quality. As an illustration of the variable effect of the air delivered through the tuyeres during a succession of cycles of stove changes from 455 to 705 deg. C., on the working of a furnace producing 600 tons weekly, observations were made on the gas, air and steam pressure conditions. The furnace was running on a fuel ratio such that all the steam produced was swallowed by the turbine driving the blower. The volume and pressure of air blown was kept constant in one case, whereas in the other the turbine was free to take advantage of the rise in steam pressure resulting from any fluctuations in the thermal value of the gases passing through the boilers.

With constant volume and pressure of air blast the steam pressure at the boilers rose as the air temperature increased and fell as the stove cooled. The slag became more basic as the temperature of the air increased, showing that with the hotter air more iron and of higher silicon content was being made as the blast temperature increased, though only the same weight of air was being supplied.

In the second and probably more normal conditions—where the blower speeded up as the temperature of the air increased—the difference between the peak and trough of the blast temperature fluctuations caused markedly greater fluctuations in the slag condition and in the make per minute. This experiment on a very sensitive furnace producing a 1.5 per cent. silicon type of iron shows clearly how variations in blast conditions influence the character of the iron produced, and prevent absolute uniformity of product. The case cited emphasises the deduction that in cold-blast furnaces such variable conditions do not prevail.

It is interesting to study a series of comparisons in three types of furnaces representative of cold-blast, large and medium-sized hot-blast furnaces, the former of rapid-driven type. Taking 40, 60 and 80 feet height of stock column; 50, 1,000 and 1,350 deg. C. as blast temperatures; 6 ft., 9 ft., and 14 ft. hearth diameters; 150, 600 and 2,000 tons of iron per week from 45 per cent. iron in the ores charged; 35 cwt., 25 cwt., and 20 cwt. of coke per ton of iron smelted, the following comparisons may be noted:—

TABLE II.—*Showing Comparison of Working Between Cold-blast Large and Medium Sized Hot-blast Furnaces.*

	Furnace A.	Furnace B.	Furnace C.
Velocity of gases (mean) through furnace per minute	150 ft.	318 ft.	180 ft.
Speed of burden descent per hour	1.5 ft.	4.0 ft.	5.0 ft.
Weight of blast per ton of iron	216 cwts.	135 cwts.	120 cwts.
Iron per sq. ft. of bosh per hour	15 lbs.	43 lbs.	100 lbs.
Velocity of gases through boshes per second	2.0 ft.	5.3 ft.	8.0 ft.
Iron per sq. ft. of hearth per hour	78 lbs.	140 lbs.	170 lbs.

Among the main hindrances to uniformity is the imperfection of charging due both to mechanical and hand methods. In some works there is a great temptation to charge occasionally, large lumps of metal which rarely fall far from the lining and descend in that position to the hearth. Such lumps have been occasionally seen in front of the tuyeres still imperfectly melted, and all ready for the production of a mass of oxidised metal which cannot but affect the iron in the hearth, and if of different analysis to that desired, still more obnoxious. J. E. Johnson, Junr., has drawn attention to the difficulties attached to many defects in the dumped distribution of material from the bell, either resulting in too much fine ore at the circumference of the shaft or at the axis, and vice versa. Though hand charging can in careful hands give remarkably uniform results, yet it is not uncommon to find the opposite. After "slips" and "hanging" troubles, blank charges of coke not infrequently tend to irregular metal until normal conditions return. Hard taps, wet pig beds—leading to "boils" and incidental pig troubles, all find their reflection in later troubles at the foundry cupola. Many of these difficulties will occur and are as obstinately refractory as the weather—which factor, by the way, cannot be ignored in this country of many weathers.

The writer has encountered numerous cases where in small furnaces a run of wet weather has so affected fine clayey ores that the casts for weeks have been of very variable nature. Especially is this the case when the critical irons on the border line between mottled and grey were being made. The really remarkable constancy of grades often produced under most trying conditions is a tribute to good furnace-craft, but, with all the care possible the guarantee of making irons of definite analysis must remain difficult, and the foundryman must recognise this. With the variable ores at his disposal the increasing temptation to speed up and economise in fuel and labour must make the production of uniformly satisfactory grades more and more difficult. It must be obvious, however, that, as in so many other directions, high speed working does not run coincidently with quality of product. In the smelting of foundry irons the smaller slow-running blast furnaces, using moderate temperatures of blast, give good and regular irons. Without holding any brief for cold-blast iron makers the author concludes that, on scientific grounds, their irons must hold the field for quality and regularity of product. The hot blast furnace can be fed with steel turnings and the like with the view of giving a kind of semi-steel (so-called) product, but, though lower in total carbon, it is not the same metal as that produced in a hearth supplied with blast of non-varying temperature; with a slow speed of burden descent and efficient carburisation, free from the oxidation defects due to drastic high temperature and high velocity blast jets, and a long quiescent opportunity for the metal in the hearth to obtain homogeneity of composition.

Graphite Ratio Constant.

The relationship of graphitic carbon content to total carbon content in pig iron is a vital one and is perhaps more indicative of fracture characteristics than any other, though not reliably so in cases where sulphur, manganese and phosphorus play an abnormal part. In any furnace, however, working regularly on fixed burdens there is generally a definite ratio of graphitic carbon per cent. or of total carbon per cent. which follows a definite

curve if plotted on a base graduated in terms of the combined carbon content in the pig iron. Such a curve is characteristic of the furnaceworking and, if a theoretical curve, constructed from the formula for giving the total carbon in a eutectic iron of the same Si P and S contents be plotted against the actual it is easy to see the difference between the given irons and the standard eutectic type, and at once gives the clue to the temperature conditions in the hearth, under which the irons were made. The writer has found the characteristic curves to vary in irons cast from the same furnaces when made in summer and winter (see analyses marked S and W in Table I.), and this is in accordance with conclusions arrived at from the study of the curves producing such differences. Differences in the dryness factor of the blast, tuyere zone temperature, blast penetration, and the influence of casting in colder and damper pig-irons have their effect on the higher contents of graphitic and combined carbon. Such differences in the ratio vitally affect the fracture, though the Si Mn P and S contents remain the same, and are frequently a cause of error in judgment if the metal be simply adjudged from the usual analysis standpoint. Those defects, which are traceable to irregularity in the metal composition, chemically and physically, will, from the foregoing, be readily seen to emanate often from difficulties in blast-furnace practice which are and must remain almost impossible to overcome. The scientific foundryman, however, will recognise that he may, if he will, carefully examine the composition of his iron by chemical analysis, and from a comparison of any iron with the ideal eutectic iron of like composition be able to judge whether or not he is in possession of an iron produced under excessive temperature conditions in the blast-furnace hearth.

(To be continued.)

Cutting by Electric Arc and Oxy-Acetylene Under Water.

Mr. Robert G. Skerrett, writing in a recent issue of the "Iron Age," gives some interesting details of the great advances which have been made in the art of submarine metal cutting. In the course of his article Mr. Skerrett stated that it has long been realised that much could be gained if a torch capable of working under water could be devised, for service in cutting metal bodies of one kind or another. To this end, the Germans brought out some years back a sub marine oxy-acetylene torch.

Broadly stated, the gases were discharged through a cup-shaped nozzle, and the flame was generated at the inner centre of this vessel. The pressure of the expanding gases was relied upon to prevent the enveloping water from flooding the nozzle. Further, the force of the gas blast also served to wipe away or to scatter the metal made fluid by the heat of the flame. If the position of the nozzle opening or the impulse of the stream of gas was such that the water could inundate the cup, then the flame was extinguished, and it was necessary to carry the torch to the surface to relight it.

In using this torch, care had to be exercised to hold the nozzle downward—at least not to raise its mouth above the horizontal. And the flame could not be kept alive unless the pressure of the repelling gases considerably overbalanced the hydrostatic pressure at the operating depth. In short, this submarine-cutting apparatus was found effective only at comparatively shallow depths. Nevertheless, the Germans pointed the way, and proved that a bare flame could be kept burning when submerged. This much was clear gain.

During 1918 and 1919 the French naval authorities became much interested in efforts made at Lorient to improve upon the earlier German torch, and to devise comparatively simple attachments by which the ordinary oxy-acetylene torch might be operated under water in dealing with marine salvage problems, of which there were then many.

The nozzle finally evolved for the work was a double-walled affair, the inner tube constituting the flame chamber. From between this tube and the outer sleeve was discharged a stream of compressed air at sufficient pressure to form an atmospheric envelope for the flame. The force of this air held the water at bay while the torch reached the metal so bared.

While the French found that their torch was apt to be extinguished if the nozzle touched the metal surface, yet the tip of the apparatus had to be held from it a distance of but a few millimetres. It has latterly been reported that they have improved upon the apparatus, so that it can be ignited under water by chemical action; this obviates necessity for the diver to return to the surface to relight the gases. But there is nothing to indicate that this torch has yet gone beyond the experimental stage.

Staten Island, by reason of the break, was cut off from the Catskill water supply system for several weeks, and this period of isolation would, undoubtedly, have been a good deal longer but for the aid rendered by submarine cutting torches in facilitating the removal of the damaged piping.

Mr. Ralph E. Chapman set about adapting the oxy-acetylene torch and the electric arc for subaqueous service. The improvements evolved did much to insure a more nearly continuous working of the cutting flame; and by means of this apparatus 12 holes, each about 14 in. in diameter, were made through as many steel barriers. This introduction of the electrical feature marked an advance in the art.

The torch used on the submarine was simple in its get-up. Its operative parts, at the working end, consisted of a carbon electrode, a few inches long, traversed longitudinally by two small gas conduits—brass tubing about $\frac{1}{8}$ in. in external diameter. The pressure and the quantity of gas conform with the operating depth. All the diver has to do is to bring his tool close enough to the metal to be cut to cause arcing; and the best effect is obtained when the electrode is something like $\frac{1}{4}$ in. away from the "ground." The electrode is connected to one pole of a generator, the other pole being grounded through the water to the work. Acetylene is not employed. The "cutting gas," of a nature not disclosed, is supplied from the surface through a suitable hose, within which is carried also the electrical conductor.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cupola Practice.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—*Re* Mr. Barlett's report in connection with my lecture published in last week's issue of the FOUNDRY TRADE JOURNAL, which contains many gross inaccuracies.

The first figures he gives are wrong, and should be 3 ft. 6 in. not 4 ft. 6 in.; the second figures should be 2 ft. 9 in., and not 2 ft. 6 in.; and if he will work out the area required for 5 cwt. of coke he will find it is quite impossible for it to reach anywhere near 3 ft. above tuyeres in a cupola 2 ft. 9 in. internal diameter, with the tuyeres 2 ft. from the sand bed.

Furthermore, the scrap he calls rain-water pipe was actually water-main pipe, which is quite a different class of scrap.

I also must take very serious exception to his describing the metal as dull and pasty; this displays very bad taste. The practical foundryman will also realise pasty metal will be more suitable for the puddlers than for castings; on the other hand, I can produce electric switch-boxes that were cast with this pasty iron measuring 1 ft. 6 in. long by 4½ in. broad by 5 in. deep by less than 3-16 in. thick, on the occasion when the London Branch members visited our works.

Yours, etc.,

J. J. MCCLELLAND.

Palatine Works, Isleworth.

[We regret that on account of a slight illegibility of the MS. the diameter of the cupola appeared in the report as 4 ft. 6 in. instead of 3 ft. 6 in., the correct figure.—ED.]

Factory Accounts, Costs, and Statistics.*

By R. Dunkerley (Works Accountant, Metropolitan Vickers Electrical Co., Ltd.).

The present depression in trade has probably brought home to many employers the fact that the day of management by rule-of-thumb methods is now practically gone, and that if they are to compete in the world's market prices must be rock bottom, and to get these it means that production must be at its highest level and cost of production at its lowest level.

Every founder believes that he can attain this state of efficiency, and where it is not attained the blame is, in nearly every case, laid on the employees. This may or may not be justified, and to get at the facts the keeping of records is required—records not only of wages paid and value of materials used, but also records of output in relation to some factor, such as the man-hours per ton, cost per lb., selling price per lb., etc. It is also necessary that close and careful watch shall be kept on all the extraneous factors, such as cost of administration and general commercial expenses.

The extent to which statistics are necessary is, of course, dependent upon the size of the foundry, but even in the smallest foundry a book record accurately kept is far more useful in a case where rock-bottom figures are required than is the manager's general impressions and approximations of possibilities.

In making these remarks, the view is naturally taken of the larger foundry where it is necessary to keep some amount of scheduled information, but at the same time it ought to be understood that whilst fundamentally all foundries require information, the degrees of this and the degrees of applying it must be varied to suit the immediate conditions.

FOUNDRY CONTROL STATEMENT.

Debits.	£	s.	d.	Credits.	£	s.	d.
Balance of stock in hand and jobs in progress ..				Value of deliveries ..			
Total wages—							
Productive				Loss from trading statement ..			
Non-productive ..							
Total purchases of raw materials				Balance of stock in hand and jobs in progress ..			
Total overhead expenses							
Profit from trading statement							
Total .. £				Total £			

FORM I.—*Foundry Control Statement.*

To speak of scientific management of foundries and works to some managers has the same effect as the waving of a red rag to a bull. Managers have been heard to comment that factories and foundries run on scientific lines rarely, if ever, pay dividends. Perhaps in some cases they were right, but if they went a little deeper they would probably have found that if scientific management had not been applied the firm would have ceased to exist.

We are a conservative people, and we have to have many things thrust upon us before we appreciate their value, and management on scientific lines has to be thrust on many managers before they appreciate it. It is believed that this same process is now forcing itself on foundries.

The boom period which followed the moulders' strike appears to have given many founders the idea that if they could produce, that was all that was required. Now, in the slump period they are realising that production at any price is a thing of the past. It is necessary now to quote minimum prices, and the difficulty is to find what these are.

Continental competition is again entering the market at specially cut prices, and to retain business firms are quoting competitors' prices without realising what loss is being incurred. Prices for the home market have suffered in consequence, as the founder in many cases is only interested in the final figure, and if his general average comes out all right he assumes that it is a paying proposition and he is making all the money he can. How many founders consider the proposition of what business they are losing due to the high prices they are charging on one class of article to make up for the deficiency on another. If they knew the facts the probability is that they would reduce the business on which there is a loss to a minimum, where it is to be done as a policy, or eliminated altogether where possible, and concentrate on the more profitable lines, and it is to help to decide which class of goods fall in these categories that costing is useful to the manager.

COMPARATIVE FACTORY EXPENSES.

.....Department. Year 192....

No. of Working Days .....

Factory No.	Description.	Last year's average. £	Jan. £	Feb. £
	Standing charges—			
	Depreciation			
	Fire insurance			
	Rents, rates, and taxes ..			
	General maintenance of buildings and grounds			
	General maintenance of buildings equipment			
	Sub total			
	Indirect charges—			
	Purchasing and storekeeping ..			
	Stenog. and mailing			
	Unaistd. sundries			
	Education			
	Works transport			
	Main production			
	Watchmen and janitors ..			
	Management, employment, and superintendents			
	Factory accounts and costing ..			
	Research			
	Furniture (direct)			
	Sub-total			
	Direct Charges—			
	Steam			
	Power			
	,, Lighting			
	Heating and ventilating ..			
	Compressed air			
	Water			
	Gas			
	Storekeeping			
	Shop sweepers			
	Miscellaneous shop labour ..			
	,, material ..			
	Testing new material and apparatus			
	Charge hands			
	Inspectors			
	Foremen and assistant foremen			
	Foremen's clerks			
	Crane drivers			
	Slingers			
	Production clerks (dept'l.) ..			
	Stationery for works depts. ..			
	Overtime and night allowances			
	Waiting for material			
	,, tools and drawings			
	,, instructions ..			
	Waiting due to breakdown ..			
	Waiting for power			
	,, crane			
	Maintenance of tools			
	,, patterns ..			
	,, cranes, small trucks, and handling apparatus			
	Process and rate fixing.. ..			
	Insurance, Health			
	,, Accident			
	,, Unemployment ..			
	Defective workmanship ..			
	Total			

FORM II.—*Comparative Factory Expenses.*

Underlying Principles.

Costing information can be divided into three headings :—

(a) General statistics, dealing with information respecting output in relation to other factors, number of men, wages paid, etc.

(b) Foundry accounting, which deals with financial information in bulk.

(c) Foundry costing, which must deal with information in detail.

In advocating the introduction of efficient accounting and costing systems it is not the intention to convey the impression that the introduction of these will make a business a success. What is claimed, however, is that if proper use is made

* A Paper read before the Lancashire Branch of the Institution of British Foundrymen.

of the information provided it will be of the greatest possible assistance. Systems need not necessarily be elaborate, nor are top-heavy systems useful, but it is essential that the information obtained is accurate.

It is not fair that the line should have been taken up by the foundry manager, that the clerical people are there to gather the information without his help. It is necessary that the closest co-operation should exist between them, both in the compilation of the information and in the studying of the results obtained.

Essential Details.

The first essential to the success of any system is that proper details of all expenses be received and their dispositions acounted for. Firstly, the employee must account accurately for the money paid to him in wages, by giving details of the time he spends on the various jobs.

Secondly, money expended on materials shall be accounted for by keeping an accurate record of the material passing through the cupola and used in the foundry. This involves proper records of stores received and issued.

The third factor is that the whole of the overhead expenses shall be recorded under their various headings so that they may be watched, and in order that they may be distributed in such a manner as to ensure that each job bears its fair proportion.

To ensure the collection of all expenditure and to have a check figure against which to balance stock at stock-taking periods, some sort of a control account is necessary. This can be a simple one, as shown in Form I., or it can be more detailed.

In the account shown the first item is the value of the stocks held, and the value of the jobs in the foundry. This can be obtained either from stock records or from stock-taking valuation.

Then there are the wages paid. This is the total amount from the wages book. For purposes of control it would be advisable to divide these into productive and other. Purchases of raw materials are obtained from invoices, and should agree with amounts posted on stock records. Overhead expenses are the salaries and wages paid to employees not on the shop wage roll; for instance, foremen, salesmen, storekeepers, clerks, etc., the cost of repairs to plant; rents, rates and taxes; machine purchases and all materials not used in actual production. In Form II. are outlined some of the charges under this heading. In this control account will also be shown the profit or loss made as given by the trading statement.

Foundry Tackle.

On the other side of the account is the value of deliveries; this, of course, is the value of the castings shipped from the foundry and also the value of certain foundry tackle made. This subject of foundry tackle charge is a much discusesd one, and probably it would be well to divide it into three grades. Firstly, that which is made for a specific job and which is afterwards no use. Secondly, that made for general use replacing other used tackle. Thirdly, that which is made and is an addition to the foundry equipment, and therefore must be capitalised.

The first, of course, should be included in the price of the job charged to customers and costed to the job.

Those coming in the second class should be credited to output at the prices of labour and material and charged back to overhead expenses against shop-equipment maintenance.

The tackle made for general foundry use and the value of which it is intended to add to capital should be passed through the foundry on a specific Order No., just as if it was a customer's order. The only difference would be that where an invoice would be rendered to the customer, the amount would be charged to your own capital account.

The balance of stock on hand and jobs in progress is again obtainable from the valuing of stock records or by an actual stocktaking valuation.

If the records are all correct, the two sides of the control statement would balance, and it is then sure that the cost charges keep in line with the financial books.

The common practice of the trade is to divide the products up into a series of classes. These may be on a weight classification, say 1 cwt. and over 1 cwt., or they may be in any variation of classification to suit the particular type of trade done. To provide for this, all the information which is required is the average cost per lb. of metal, and the prices charged for the various classes is in some predetermined ratio.

Generally, information of this kind is useful and easily obtained, but it does not do away with the difficulty of not knowing which are the paying jobs.

Monthly Statements.

Form III. is the outline of a general foundry monthly statement and trading account, which covers the main points which are essential to give an adequate idea of foundry productivity. Taking the production side first, and dealing with output, the first item is "Castings Shipped." This, of

STATEMENT OF FOUNDRY TRADING.

Details of costs.	£	s.	d.	Unit cost per lb.		£	s.	d.	Unit cost per lb.
WORK IN HAND (for previous month):					CASTINGS SHIPPED:				
Section No. 1—Labour hours.					(Priced at class value.)				
Overhead per cent.					Section No. 1—Weight				
Section No. 2—Labour hours					Section No. 2 ,, ...				
Overhead per cent.									
ADJUSTMENT OF WORK IN HAND:					CASTINGS IN PROGRESS:				
Section No. 1—Labour hours					(Priced according to stage of completion.)				
Overhead per cent.					Section No. 1—Weight				
Section No. 2—Labour hours					Section No. 2 ,, ...				
Overhead per cent.					WORK IN HAND:				
LABOUR COSTS:					Section No. 1—Labour hours				
Moulding (from wages book)					Overhead per cent.				
Coremaking ,, ,, ...					Section No. 2—Labour hours				
Fettling ,, ,, ...					Overhead per cent.				
MATERIAL COSTS:									
Pig-iron					FOUNDRY EQUIPMENT:				
Scrap									
Coke									
Sand									
Plumbago, etc.									
Oil									
Miscellaneous									
OVERHEAD:									
Estimated percentage									
Actual ,, (difference) ..									
BALANCE (IF PROFIT)					BALANCE (IF LOSS)				
	£					£			

Production details.	Lbs.	Material details.	Average Costs in pence per lb. Nett output.	1st period Lbs.	2nd period Lbs.
Castings shipped		Pig-iron.	Labour		
,, in hand		Scrap.	Overhead		
Less amount in hand at beginning of period ..		Coke.	Material		
		Sand.			
Net weight produced..		Oil.	Total cost per lb.		
		Plumbago.			

FORM III.—*Statement of Foundry Trading.*

course, is the value of the castings actually despatched during the period. These are, of course, valued on class price, and assuming two sections or cupolas, the amounts shipped from each are given both in weight and in value.

The second item is "castings in progress." These are the castings, which at the end of the period, lie on the floor of the shop either in the moulds or unfettled. These, again, can be divided into the classifications and valued at class prices according to stage of completion, for the purposes of the statement.

The third item is "Work-in-Hand." This is the value of work which has been done on unfinished moulds or cores. If time is booked and cost records are kept, this is, of course, obtained by adding up the hours outstanding on the cost sheet at the end of the period. If no cost records are kept, it will be necessary for this purpose to have an approximation made of the hours represented by the work done. To this labour is to be added the overhead applied by the method adopted in the particular shop, and again the work would be divided into the various foundries.

The next item is the amount of foundry equipment made. This can be given in bulk. This item has already been dealt with fully previously in the paper.

In the States no credit is given whatever to the foundry for the making of equipment unless it is standard equipment which is to be used for many jobs, in which case it is only made against a definite order and capitalised. In all cases it is assumed to be a manufacturing expense and either booked against general overhead or the labour and material is added to the particular job.

The addition of these items gives us the total value of the output and work in hand.

On the other side of the statement is the value of work in hand at the beginning of the previous month—this will be an exact copy of the previous month's figures under output. This must be taken care of, as, of course, during the month, the output for that month will consist of some of the work partially done in the previous period. Therefore, obviously it is correct to charge the value of the work outstanding at the beginning of the month, and on the other side give credit for the work outstanding at the end of the month.

The adjustment between the amount transferred at end of previous month compared with value at end of current month is covered in the next item, and also it will be noticed that these figures are not included in the total expenditure for the month, but have a bearing on the cost per lb. of output, and are taken care of in the last column—either debit or credit, *i.e.*, where amount at end of period is more than at the beginning, this will be a credit, and where less it will be a debit, as obviously output will have been obtained at expense of work in hand.

Labour Costs.

The next item is labour costs. These are divided up into four headings—cupola labour, coremaking, moulding, and fettling labour. The costs of the cupola labour is, of course, added to the material cost for the month. This represents the labour which has been expended on the material up to tapping. The other labour, naturally, is the actual labour cost on the material at the various operations.

Material Costs.

Under the material costs are collected the values of the various materials which have been used during the period. This information will be obtained from the requisitions given to the storekeeper when materials are withdrawn and priced at the purchase prices of the material.

Overhead Charges.

Overhead expenses are divided into two parts—"estimated" and the adjustment for "actual." In charging out during the month the agreed percentage must be charged, since it is not practicable to wait till the month end before charging out, and this is what is covered on the statement (Form III.) as "factory expenses" (estimated). At the end of the period, when the total actual expenses are available, this amount is adjusted by the difference between the amount estimated and the actual. It may, of course, be a credit. The total of the two sides are then compared, and the difference is profit or loss during the period.

In the lower part of the statement are given the general statistics affecting the foundry.

The production details in lbs. consist of weight of castings shipped and in hand. The total of these less the weight of castings in hand at the beginning of the period gives the net production of castings during the period.

GENERAL FOUNDRY STATISTICS.

	Period 1.	Period 2.	Period 3.	Period 4.	Period 5.
Cost in pence per lb.:					
Labour					
Overhead					
Material					
Total					
Sales price in pence per lb.					
Profit or loss in period					
Output in lbs...					
No. of working days					
Output in lbs. per man hour					
Overtime, per cent. to total hours					
Average hourly pay					
Wastage, per cent.					

FORM IV.—*General Foundry Statistics.*

Under the heading of material is given the weights of the different ingredients passing through the cupola. The proportions of these is a good and useful index figure.

By comparing the net weight of the casting produced with the weight of material passed through the cupola, a wastage figure can be obtained. This should be a fairly constant percentage, and wide differences would naturally call for investigation.

By dividing the net output into the value against the various items on the sheet the unit cost of each of the different items can be obtained.

These unit-cost items will then be summarised into a cost per lb., as shown, and the suggestion is made that the placing on the sheet of the previous periods cost result, shows any immediate alteration. It is helpful also to show the net production during the period. A low production may influence the overhead cost very considerably, as whatever the production may be, the standing charges, for instance, remain constant.

The Utility of Summary Sheets.

For purposes of closely watching the information gained by a summary sheet such as this, tabulated lists of results can be obtained, and comparisons watched from period to period. Form IV. shows a sample of these statistics and general foundry statistics. They can also be usefully shown by graphs and a visual picture obtained.

(To be continued.)

HENRY PONDER & COMPANY, LIMITED, 45, Bethnal Green Road, London, E.1, have purchased the business of Malcolm C. S. Bowley & Company, metal merchants and brokers, 21, Cullum Street, London, E.C.3.

XUM

Castings for Internal Combustion Engines.

By Ben Shaw and James Edgar.

PISTONS.

The production of suitable castings for pistons is frequently a source of worry to the foundryman because many become wasters in consequence of cracks which develop after the castings have cooled down. Sometimes this weakness is known directly after cleaning, or it may not present itself until the casting has been machined, while in other cases cracks may develop during trial when the piston is actually in use. The design of these castings is frequently responsible for this weakness, the varying thickness of metal and the drawing tendency of the comparatively heavy bosses creates internal stresses which are difficult to avoid. Even in these comparatively simple castings, the varying designs and the complexity of many of them, from the point of view of metal thickness, give the founder much trouble.

Though some designs are more difficult than others to cast, the character and quality of the metal of which they are composed have a considerable influence on the quality of the casting, and it is in this direction particularly that the foundryman must necessarily concentrate his knowledge and experience in order that the castings may conform to the exacting demands made upon them. Various alloys have been tried for pistons, those of aluminium having been successfully employed in special cases. The alloys from which they are cast consist of copper, zinc, iron, silicon, together with the aluminium; sometimes a very small amount of manganese and magnesium are included.

Heat Treatment of Pistons.

Aluminium alloys are subjected to heat treatment to dispose of internal strains, either by boiling in oil at a temperature of about 150 deg. C. or, by the use of an annealing furnace, in which they are heated to a temperature of 425 deg. C. and then allowed to cool under normal conditions.

Semi-Steel Mixtures.

The production of castings from these alloys is comparatively limited, as satisfactory commercial results are obtained by using a suitable cast-iron mixture. Usually the mixture prepared for the cylinders is used for the pistons also, a semi-steel being particularly suitable. The composition of a reliable brand being 3.0 per cent. total carbon, 1.7 per cent. silicon, 0.6 per cent. manganese, 0.45 per cent. phosphorus, and 0.07 per cent. sulphur. Sometimes the pistons are cast sufficiently long to provide the rings, but it is much better to make separate castings from which numbers can be cut, and, incidentally, it is preferable to use a mixture of slightly different composition from that used for the pistons. These rings should consist of greyer metal, but not such as to interfere with the spring. A suitable composition being 2.6 per cent. total carbon, 1.3 per cent. manganese, 3.7 per cent. silicon, and 0.1 per cent. sulphur. These mixtures cover the requirements for ordinary commercial work from which good castings can be made.

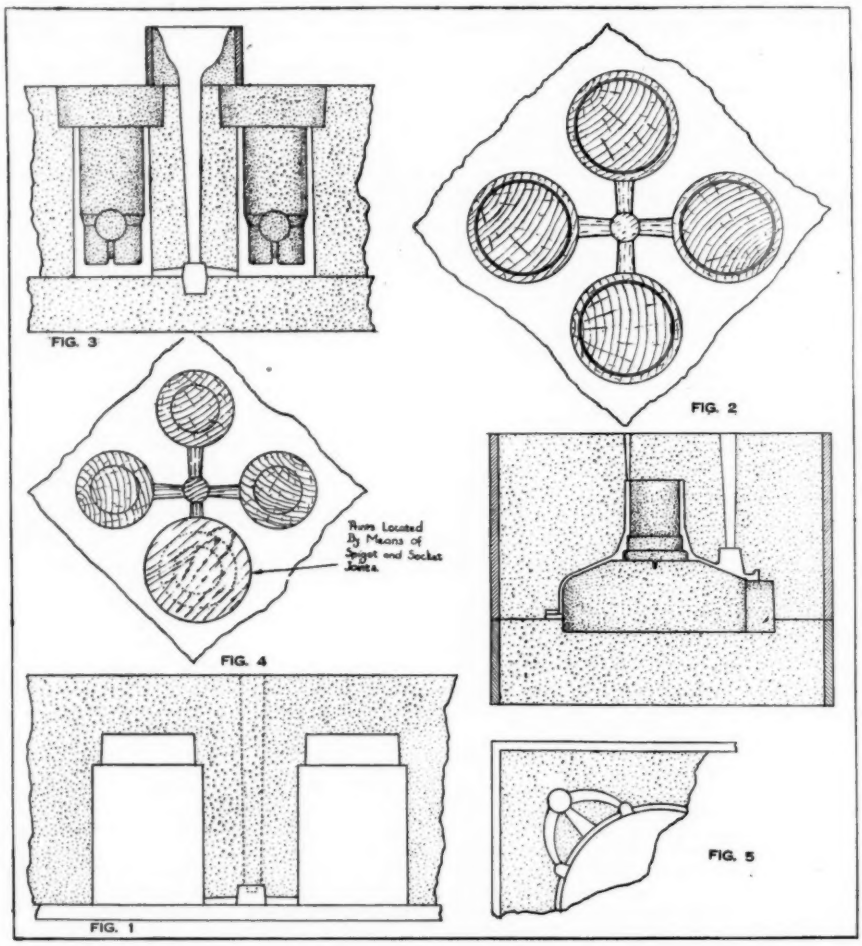

FIG. 3. FIG. 2. FIG. 4. FIG. 5. FIG. 1.

Moulding Details.

The actual moulding involved in the production of these castings is comparatively simple, and yet considerable diversity of opinion exists as to the most suitable methods. We have illustrated two methods for purposes of comparison. Fig. 1 shows a section through a mould arranged to cast with the open end of the piston down. It is contended that when this method is used risers can be used which feed the thicker parts of the castings, then, owing to the thinner part being cast-down, the

metal enters readily, and its temperature need not necessarily be high. When this method is adopted a number of patterns are usually attached to a plate, as shown in Fig. 2. Mounting four patterns is the customary practice, and one runner is used with a sprue to each mould. One of the drawbacks to this method is the difficulty in setting the core, as it must be lowered below the joint surface of the mould, and a perfect fit in the print impression is essential, otherwise the core will float when the metal is poured. A small template should be used to make sure that the top thickness is correct. The method more frequently employed is to prepare for casting the other way up. The patterns are mounted similarly, but the gate is used as shown by the dotted lines in Fig. 1. With this method, a head can be cast on the open end and greater pressure, when casting, gives the metal a closer texture about the closed end where it is very desirable; furthermore, it gives the advantage of bottom pouring. In this method the core is suspended in the cope, it being wired to maintain its position. Another method is sometimes employed for supporting the core, which

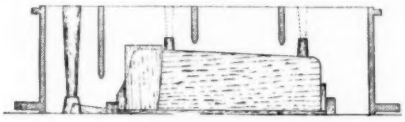

FIG. 6.

has the advantage of being located more easily, and it dispenses with the need for wiring.

Such a method is illustrated in Fig. 3. In this instance the drag merely takes the bottom impression of the gate, the cope taking all the mould, the enlarged part of the core at the top giving the cover. When this method is adopted it is customary to make the height of the print such that the total height of the pattern coincides with the height of the box part to be used. These, too, are usually arranged to cast four at the same time, as shown in Fig. 1. In both these instances the moulds must necessarily be clamped before pouring; in the latter case it is necessary to weight the cores, and a skimming gate at the top is desirable. Hotter metal is required when the open end is cast up, but it need not be poured so quickly.

Crank-Case Bottom.

Of the detail castings required in aluminium the bottom part of the crankcase gives as much trouble as any. What has already been said with reference to aluminium applies with equal force in this instance. The correct pouring temperature of the metal is of vital importance. The lowest temperature which will successfully fill the mould is that which gives the best results. In some foundries these are run by the use of plumb gates, much in the same way as cast-iron baths; it is, however, more advantageous to adopt bottom

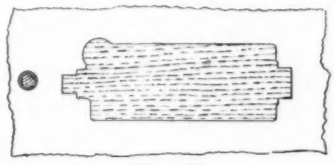

FIG. 7.

pouring, so that the flow of metal is disturbed as little as possible, and so reducing the chances of aluminium oxide collecting in the metal and being trapped. Risers are, of course, essential to feed the heavy sections which come in the top of the mould, but the bosses carried in the main core may have denseners to make the cooling more rapid, so that its rate of cooling approximates more nearly to that of the remainder of the casting. From all points of view these castings are more accurately produced, and they have a better finish when a suitable moulding-machine is used. Even without a pattern drawing-device, the sand is consolidated more regularly, an important consideration in moulds to receive aluminium, but with a pattern-drawing arrangement the accurate withdrawal of the pattern dispenses entirely with cooling. In this case the drag only carries the print impression and part of the skimming gate.

The pattern should be secured to a plate, with suitable sprues attached, runner and skimming gate, as indicated in Fig. 5. It is convenient to use dowels for locating the gate and risers and for keeping them in position while the sand is being introduced into the box. The print and the other part of the skimmer may be attached to the other side of the same plate, making a form of match-plate, but it is preferable to use a separate plate for convenience. An ordinary solid box with straight bars will suffice, such as is shown in Fig. 5. When one machine is operated for both cope and drag it is advisable to prepare a number of drags so that the cores can be set ready to receive the copes as they are finished.

The small boss shown on the outside of the pattern will need a densener, a small piece curved to the shape of the boss being laid upon it and enclosed in the sand. The core can be most readily produced on a jolt ramming machine. An oil-bonded sand is preferable, as it quickly carbonises

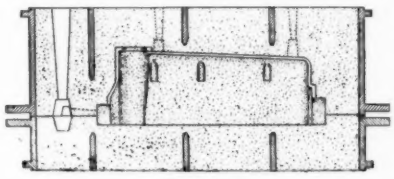

FIG. 8.

and it does not reduce the pore-space. A part sectional view of the box, showing the relative position of the pattern with regard to it, is illustrated in Fig. 6. In some cases a thin print is preferred for the core which forms the hole in the filter branch; it is, however, quite unnecessary as this core is more satisfactorily carried with the main core, and it should be set so that the cope barely touches it when it is lowered for casting. The shape of the print carried on the plate for the drag is shown in Fig. 7, and a section of the finished mould preparatory to receiving the metal is shown in Fig. 8.

It will be noted that the skimming end of the gate is carried partly in the drag and the gate is comparatively large; this is necessary to give a good supply of live metal. Bushes should be used for riser and pouring basins in order to increase the height and, incidentally, the pressure of metal. The prepared basins for pouring aluminium should be deep rather than shallow, and a head of metal should be maintained until the risers are full.

The Water-Inlet.

There are a number of varied forms of this type of casting; sometimes individual branches connect to the cylinders. The more common type, which has a full connection over the number of

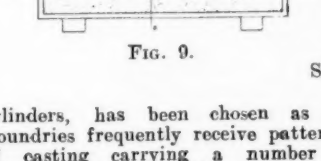

FIG. 9.

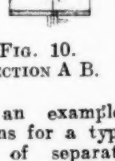

FIG. 10.
SECTION A B.

cylinders, has been chosen as an example. Foundries frequently receive patterns for a type of casting carrying a number of separate branches, with the prints from these branches following the diameter of the holes required, and as a rule no effort is made to lengthen them. When this occurs, the moulder must necessarily chaplet the core, as it is unbalanced. Chaplets, however, should be excluded from this form of casting unless it is impossible to dispense with them. When individual branches are carried, then a block print should be used, so that the core is well balanced between the inlet branch print and the block print. When this method is adopted it relieves the foundry of much trouble and a better casting is produced. The core provides the face for the major part of the joint flange when a block print is used, and it makes a sounder job.

This inlet casting, though similar to, differs

slightly from the preceding castings in the method of running. In this instance it is more convenient to supply the metal by way of the joint, particularly because of the bosses which are cast-on. These bosses form thicker metal, and they are likely to be spongy unless they are fed. This can be provided for by running the metal as indicated in Fig. 9; then, besides supplying metal, the sprues also act as feeders to the heavier sections. The main runner should be large enough to maintain a continuous flow of metal through the sprues. The pattern for this casting would be parted longitudinally along the central plane, and it is very convenient for locating on a plate for the purpose of moulding on a machine. When there are suitable boxes, it is quicker and more convenient to set both halves of the pattern on one side of a plate in such a way that two impressions taken from will coincide when brought together. Only one main runner need then be used, and it would save changing the plate for making the copes; a couple of risers from the top of the flange would suffice. It is much safer and more convenient for the operator of the machine if provision is made for locating the risers and the gate stick. A section through the mould is shown in Fig. 10. It should be noted that the cope comes directly in contact with the core at the ends during the time of lowering, hence it is advisable to have plenty of taper on the print; the core, however, need not necessarily be made to carry the same taper as long as it can be set easily and accurately.

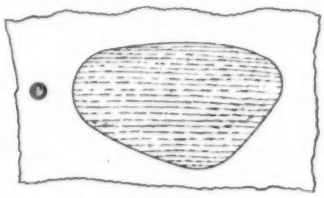

Fig. 11.

Front Cover.

This is a smaller aluminium casting, and it is moulded so that the open-end is cast-down and the metal supplied by way of the bottom, where the section is a little heavier owing to the presence of an internal flange. While it is necessary to give a good head of metal when casting in this way, it is an advantage, because the oxide skin which forms on the surface of the metal in the mould is comparatively small owing to the reduced area, and, once the metal has risen above the sprue, the thin covering remains and the metal travels over the top of the core from all sides with very little agitation. More oxide is undoubtedly formed, but it is not likely to become entangled in the metal apart from that which is carried on the surface, much of which will find an exit by way of the risers. The sprues should be sufficiently large to supply the metal fairly quickly. They are better made a little less than the internal flange in thickness, but should, of course, be increased towards the runner, so that the metal will flow regularly until the risers are full. The bosses about the inside of this casting are comparatively small, being ½ in. dia.; it is not, therefore, essential that risers be used. A needle-vent should, however, be brought off each, and, providing the metal is the right temperature, they will suffice. The method of preparing the pattern for machine-moulding is somewhat similar to that used for the bottom part of the crankcase. The large bottom print is located on a plate, as is also part of the skimmer, as shown in Fig. 11. The pattern is secured to the other side of the same plate, or another plate may be used according to the usual practice of the foundry doing the work.

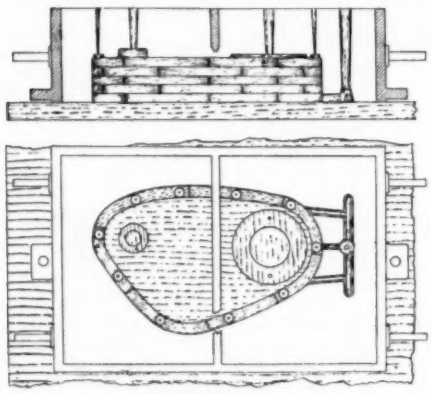

Fig. 12.

Accuracy in setting these on plates is of vital importance, and many methods are used to secure this end, some of which leave much to be desired. A good plan is to have the standard plate of one size drilled in a number of places from the one jig, and in places convenient for locating the patterns. These holes should, of course, have the same relation with the guide pins for each plate. After the print has been secured to the plate, and in a convenient place, choose about three holes through the plate which are covered by the print and bore a continuation of the holes through the print. Return the print to the pattern, and continue the holes into the pattern. When the print is removed insert guide pins or dowels into the pattern, then its position can easily be located on another plate. Fig. 12 shows the type of moulding box suitable for a job of this kind, and also the position of the pattern relative to it. The small pin holes shown are an advantage for locating the gate stick and risers.

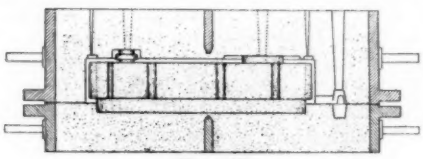

Fig. 13.

Three risers will suffice for this job, with the aid of needle vents. Prints need not be carried on the top of the pattern; as a matter of fact, it is better that they should not be on at all, the proper place for them is the core-box. Top prints, unless considerable care is exercised, are liable to cause crushing when the mould is being closed. A number of impressions should be taken of the print first, so that the cores can be set, as explained when dealing with the previous crankcase casting. After the small cores have been located it is profitable to test the heights above the main core before the cope is lowered. Fig. 13 illustrates a section of the completed mould. Provided with a first-class pattern and core-box, tooling is quite unnecessary, and only adds to the expense of producing castings.

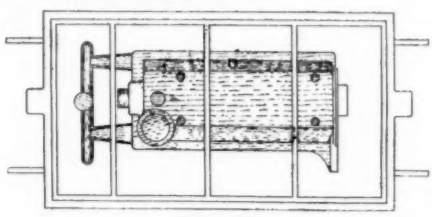

Fig. 14.

Gear Boxes.

The rear-axle gear-cases, as they are sometimes called, vary considerably in design and, incidentally, in the metal of which they are composed. Sometimes aluminium is used; for ordinary commercial work cast iron is frequently used; whereas in exceptional cases steel forms the casting material. In general, however, the moulds are prepared to be cast with the flange down. The production of the moulds on a machine closely resembles the procedure employed in connection with the front cover previously referred to; bottom pouring is preferred, and risers are brought off from the highest points, as illustrated in Fig. 14. The core in this instance is awkward. It can be conveniently made in one, when the top print can be dispensed with. Many moulders, however, prefer to have this type of core in two

pieces, and owing to its length in comparison to the diameter, a top-print is necessary to secure accuracy. When a top print cannot well be dispensed with, it should not exceed ½ in. in thickness, and it should be well tapered. The core made must possess the same taper; then, if the core is slightly out of the vertical, a grain or two of sand would be sufficient to cause it; it would engage the impression in the mould without any serious consequences. Small denseners against the outside of the lugs on the bottom flange are desirable when these castings are made in aluminium. In connection with this metal particularly, it is profitable to ease the castings shortly after the metal has been poured. It is good practice to shake them out before the metal is cooled down to the normal temperature; care must, however, be exercised in so doing, as the metal is comparatively weak and liable to be broken or misshapen if done carelessly. In releasing the casting as soon as is practicable they are considerably relieved from internal stresses, which they would otherwise be subject to.

Where Cores Reduce Time and Expense.

By F. C. EDWARDS.

A good rule, in mapping out the course for the production of castings, is to avoid coring wherever possible. One has only to recollect that every core involves at least two distinct operations—the making and the positioning in the mould—to realise the importance of this rule. Amongst other objectionable features of coring are the liability of unsightly patches being left on the casting where the edges of the core adjoin the green-sand mould, and any variation in size between core and print is bound to show on the casting. Since the pattern undergoes rapping at the hands of one operative and the core-box at the hands of another, the patternmaker has a stiff proposition before him to secure perfect accuracy of fit between core and print. Hence his aversion to coring.

In spite of the many real objections to cores, however, they possess, in some circumstances, valuable countervailing advantages. These advantages—which have been enormously increased by the introduction of oil cores—are being more and more exploited. Indeed, in up-to-date foundry practice there seems to be an ever-growing tendency to make use of cores as part and parcel

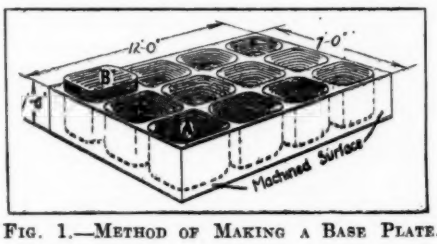

FIG. 1.—METHOD OF MAKING A BASE PLATE.

of the actual mould itself. Especially is this resorted to in those situations where, with green-sand or even skin-dried moulds, scabbing or similar evils may be expected. It may be remarked that since the oil-core is not affected by moisture, it can be built in a green-sand mould in the early stages of the job without the slightest fear of that liability to disintegration which precludes such a free use of the ordinary dry-sand core.

As an example, the base-plate shown in Fig. 1 may be cited.

To ensure a clean surface for machining, the job must be moulded face downwards, as shown. There are several methods of forming the pockets A. The pattern could have been made with core-prints as at B, and the cores finally bolted to the cope. This method is fairly common. It necessitates a completely "boxed up" pattern and prints for the pockets. There is, perhaps, a certain amount of risk in tampering with the top part after it has been rammed up, as the disturbance is not always localised. Care has also to be exercised to set correctly the cores in a vertical position.

Another method is that of casting special grids for the pockets, placing the grids on a layer of facing sand in the bottom of the pockets, ramming up the pockets, bolting the grids to the cope, and finally ramming up the cope. The chief disadvantage here is the liability to scabbing. An improvement on this method is that of making loam cakes, into which the grids are embedded, and the pockets rammed up as before. This obviates the use of facing sand under the grids, and removes, or considerably reduces, the possibility of scabbing. It is, however, a somewhat costly method.

A much simpler and more effective method than the foregoing, and one involving a great deal less time and expense, is as follows:—In the first place, the saving commences in the patternshop. The pattern is merely an exterior frame without a bottom. The ribs, which, though in their correct positions, may be regarded as a stiffening for the outer walls, require neither the usual taper nor fillets. A rough core-box is made slightly smaller than the pocket spaces, say 1-16 in. all round, and the same depth as the ribs. In the case of varying spaces, loose blocks are made to fit in the core-box, which is made to suit the largest-size pocket. With oil cores, it should be noted, special grids are not required. Rods are placed in the bottom of the box, and a loop is included for bolting to the cope. The cores are placed in the pockets, where they fit easily. The cope is lowered in position, the cores secured, and it is rammed up as usual. When the cope is removed no finishing is required.

It will easily be realised that this method, besides being less expensive, expedites delivery—according, of course, to the size of the job. The cores may be proceeded with during the first stages of moulding, to be ready for bolting to the cope when required. The time ordinarily spent in ramming up the pockets is thus saved

Industrial Electrical Heating.

A lecture on the present position and future prospects of industrial electrical heating was given at the University of Sheffield, on March 13, by Mr. J. G. Pearce, B.Sc., A.M.I.E.E., of the Metropolitan-Vickers Electrical Co., Ltd., to the Sheffield Gas Consumers' Association. Mr. D. Flather presided. Sheffield is one of the largest consumers of gas for industrial purposes in the United Kingdom.

After indicating the influence on electrical heating development of the nickel-chromium resistance alloys, the lecturer considered the relative positions of gas and electricity for heating purposes, and stated that, for a given amount of heat required by a customer, a modern super-power station used less fuel than was required in any other form of fuel conversion. The recent improvements which have been made in the manufacture of high-speed and high-capacity turbines, together with a projected scheme for linking-up power stations, would enable electrical energy to be procured at rates much more favourable than had hitherto been possible. For precision heating, electricity was unapproached by any other heating agent—it was rapid, practically any desired temperature could be obtained over a very wide range, and temperature control could be obtained within extraordinarily fine limits. Electrical heating did not distort the material, and spoiled work was almost entirely eliminated. Heaters occupied a minimum of floor space, and were less detrimental to workers than other forms of furnace. It was particularly important that those who were considering the installation of electrical heaters should not compare merely the cost of electrical energy with the cost of gas at the power station and gas works respectively, as the efficiencies of distribution and application had to be considered. In electrical heating no heat was wasted through warming up the air used for combustion, and radiation losses could be cut down to a minimum.

The lecturer then described a number of modern heating appliances, ranging from low-temperature applications in the form of ovens, soldering pots and irons, cooking and heating equipment for works canteens, etc., up to the largest electrical furnaces of the resistance type, which had been developed for the heat treatment of gun forgings, etc., taking loads up to 2,800 kw., and able to heat steel up to 150 tons: in such furnaces the resistance ribbon is inside the furnace and radiates heat directly on to the charge.

XUM

Institution of British Foundrymen.

Discussion on Mr. McClelland's Paper on "Iron Cupola Management."*

MR. H. ELLIS, in opening the discussion, expressed his thanks to Mr. McClelland for the very enjoyable visit he had had to his works. He had been very much impressed by the location of Mr. McClelland's foundry, which was unique, inasmuch as they did not often see a foundry situated in an orchard. The visit had been interesting inasmuch as it had been proved that iron could be melted at a ratio of 1 in 18. As to the central tuyere, it was very good theoretically, but he did not think it ever would work in practice, owing to the difficulty in keeping it clean during casting. With regard to spiral tuyeres on the outside of the cupola, he remembered an installation where he had the good fortune to be able to get inside the cupola. The whole of the way up, from the bottom to the top, every tuyere was blocked up. It was no use at all. The same remarks applied to the superheated receiver. In a very short time the top pipe leading from higher up above the tuyere down into the receiver became stopped up, and they had to depend entirely on the superheating from the cupola proper across the bridge into the receiver. There had been very much said about the arrangement of the charges. He remembered that some years ago it was insisted that the proper method of charging was to lay pieces of pig, edge on, all the way round, outside the cupola, scrap in the centre and coke on top. There was much to be said for aiming at a uniform rate and method of charging. One often saw a man throwing coke into the cupola, and it would all bank up on the opposite side, with the result that the iron would tumble down, and they would get melted iron by the tuyeres. Some years ago he was told Messrs. Sulzer Bros., of Switzerland, had some sort of scheme for introducing jets of steam into the furnace above the tuyeres to get the steam on to the coke and he believed they claimed more efficient melting. Then, all of a sudden, they had not time to put the steam on, and the coke was wet when put into the furnace, and they wrote to England to say that they could do exactly the same thing by putting water on the coke. Anyone who used coke must know that the coke began to get hot before the iron began to melt; therefore, what was the use of the wet coke? With regard to the ratio they had seen that afternoon, he asked Mr. McClelland whether it would be wise to use the same ratio in a larger foundry, where they were using a very much heavier class of scrap, together with pig. It had struck him as rather dangerous to use that amount of coke if charging with the average-sized pig-iron.

MR. LONGDEN, speaking of the arrangement of tuyeres, said he was not quite sure that the author had been fair to the people who advocated that kind of thing. Mr. McClelland had said that the spiral tuyere cooled the charge higher up the furnace. The idea behind it was the same as the theory behind the double row of tuyeres, the idea being that the air going into the bottom of the tuyeres, simply burned the coke to carbon monoxide, generating only 2,473 heat calories, whereas if further air were supplied a little higher up the furnace, that carbon monoxide would burn to CO_2, which would generate 8,080 calories. The idea was that it was more economical. That might be true, but there were disadvantages, which were just as apparent in the case of the double row of tuyeres as in other cases, though not in the same degree, perhaps, in the case of the spiral arrangement. It seemed to him that the best arrangement was for the melting zone to be kept as shallow as possible; it was not a good practice to have the melting zone too high, the difficulty being that there was a tendency to gob up. They would get the formation of slag, from limestone, and whatever they were using for flux melted too soon and surrounded the coke, which did not burn, as the top blast would blow on it and they would get gob. With regard to pressure, and the question of blowers and fans Mr. McClelland haid said that the fan was quite serviceable, and that he preferred it. He (Mr. Longden) had had experience of both methods, and in his opinion there was no doubt that the positive pressure blower was the more serviceable, particularly where long and heavy blows were concerned. His experience had proved that in the case of a fan it was all right if the furnace was running sweetly, and there were no hitches, but if there were a breach, the fan, on coming into contact with resistance, failed to function as the positive pressure blower. As to Mr. McClelland's design for a furnace, he had seen iron bricks used with advantage in that part of the cupola near the charging door; hollow iron bricks filled up with ganister. These were used for a depth of about 3 ft. around the furnace below the charging door, because that part of the furnace came in for very hard wear and tear. In some furnaces the charge was simply tipped in from a barrow and banged against the side of the furnace opposite to the charging door, so that the bricks there suffered severely from friction. The iron bricks were found to be very serviceable, and made for a great increase in the life of the cupola.

MR. SMITH said he thought the cupola they had seen that afternoon was very successful for the class of work for which it was used, and the coke consumption was good, but he failed to see that it would do for light castings. He did not think the iron would be hot enough for his class of work, where the ratio was about 10 or 8 to 1, exclusive of bed. The high furnace was a great advantage for pre-heating purposes. The lecturer had spoken of the Thwaites receiver type of furnace. He had helped to line one of these. That cupola had never given trouble, and there was no occasion for the furnaceman to enter the receiver portion except to reline it. The slag could be withdrawn from the front, and the top pipe was always open, and he believed that it was operating as well to-day as any in London. It had a double row of tuyeres, and was very economical.

MR. A. R. BARTLETT agreed with a great deal the lecturer had said, particularly as regards the receiver. He was most concerned with the ratio of the coke used against the iron melted for the type of work. His firm melted iron at a ratio of $1\frac{1}{2}$ to 21 in furnaces of a larger type than those spoken of by the lecturer, and it was the same with the smallest furnaces, which were the same size as those seen that afternoon. These were charged with 10 cwt. charges, with $\frac{3}{4}$ cwt. of coke. Mr. McClelland's ratio might be quite satisfactory for the work he was doing, but if he were melting iron with a different proportion of pig to scrap he would probably have to use a little more coke. Also, if his product had to stand a very high test, say 3,000 lbs. per sq. in., he would have to use more coke. He himself had tried to economise in coke, and had gone down to $1\frac{1}{4}$ cwts. with 21 cwts. of iron, but he had had to go back again to $1\frac{1}{2}$ cwts., and even to $1\frac{3}{4}$ and 2 cwts. with poor quality coke. The lecturer seemed to have very good coke indeed. He was melting a very light type of scrap, and a very small proportion of pig. He (Mr. Bartlett) took it that light scrap could be melted much more easily than heavy, and that less coke was required. He had to use heavy machinery scrap, and anything with a section of less than 1 in. would not be acceptable to him. He had calculated that Mr. McLelland's total was of 50 cwts., and that it contained only about $4\frac{1}{2}$ cwts. of pig, which was a very small proportion, and was an aid to getting such a remarkably low percentage of coke consumption against the iron melted. The lecturer had spoken of economy in charging. He (Mr. Bartlett) agreed with him as to the proper measurement of the charges put into a furnace, and the lifting of the charges, but when it came to melting metal in large furnaces, where they never charged anything smaller than half a pig under any consideration, it was a different story.

MR. FAULKNER referred to a question which had been brought up at the Annual Meeting. Mr. Riddel had said that it was undoubtedly advantageous to damp the coke, because he maintained that it prevented it burning before it got into the melting zone. He would like Mr. McClelland's opinion whether he thought it was good practice.

* This Paper appeared in March 23rd issue of THE FOUNDRY TRADE JOURNAL.

MR. CLEAVER said he had always been under the impression that certain-sized cupolas were capable of containing a certain amount of air in the melting zone, and that they melted iron according to the amount of air and carbon in the coke. The furnace they had seen that afternoon was about 2 ft. 6 in., which would be capable, on calculation, of melting three tons an hour, and it was immaterial whether the air was put in under high blast or low, so long as they got the volume of air in combination with the carbon in the coke, to melt iron successfully. He knew by experience that they could melt the same amount of iron per hour with a 5-oz. pressure as with a 16-oz. pressure. The coke per charge was a little more than that used by Mr. McClelland; in fact, it was 50 per cent. more. He did not quite agree that Mr. McClelland had melted on a ratio of 18 to 1, because there was a good deal of bed coke used by the time he had got to the end of the blow. No doubt Mr. McClelland was melting very satisfactorily and very economically, but he believed he was rather misleading himself when he stated that he was melting at a ratio of 18 to 1, because it was borne out by the experiment that a good deal of the bed coke was consumed in the melting of the iron. This had to be calculated with the charges, and the actual consumption of coke was identical with the cupola on a 5-oz. pressure and including the bed charge in both cases. This would work out at about 6½ to the ration, some of the bed coke being recoverable. The figure would be increased to a 9 or 10 to 1 ratio all told. With regard to the double row of tuyeres, he thought that theory had been condemned, and was under the impression that the single row had given the most satisfactory results. He had always taken the tuyere area to be in proportion to the size of the blast pipe and inlet to the cupola, a ratio of about 4 to 1, and from experience he had found that that had given the most satisfactory results. On a larger furnace, perhaps, a fan would not work so satisfactorily as a blower on account of the throw-back through the bridging, but he would not like to say definitely. On a small furnace of 2 ft. 6 in. diameter he should think the fan would give as good a result as could possibly be obtained.

A VISITOR said the members had certainly seen iron melted with a ratio of 18 to 1, excluding bed charge, that afternoon, for a certain class of iron, and he believed that the controversy that evening was due to the fact that they knew very little about the melting ratio for different classes of iron. The iron obtained was no doubt good enough for Mr. McClelland's purpose, but he urged that efforts should be made to ascertain what should be the proper ratio for different classes of iron. Mr. Bartlett had spoken of big cupolas, and he was sure that in the melting of iron they had the same sort of laws of mass action coming into play as in the case of the heat treatment of a piece of steel. Small pieces of steel heated up to a certain temperature in a certain time, but the big lumps took a much longer time to heat through to the same temperature, and his previous remarks would apply in connection with the melting of large scraps and pig-iron.

MR. PIERCE congratulated Mr. McClelland upon having demonstrated that he could melt iron at a ratio of 18 to 1. He understood that was the purpose of the demonstration that afternoon. Whilst he was one of those who was prepared to congratulate the lecturer, frankly he was not impressed with the iron coming from the cupola. It would certainly do for certain classes of work, but there were a great number of classes of work for which it would not do. He did not think the lecturer would deny that. With regard to the use of a receiver, he quite agreed. In most of the foundries with which he had been concerned, where they had been engaged on a very particular class of work, they had either dispensed with the receiver or had refused to have one at all. His experience was that if receivers were used, the work was nothing like so good as when receivers were not used.

MR. MCCLELLAND, replying to the discussion, said he was obliged to those who had criticised his statements, because he realised that two heads were better than one. He intimated that he himself was not responsible for having invited the members to his works that afternoon. He had not wanted the members to visit his works until he was in a better position, so that he could have given a better demonstration. He had not made any definite experiments with regard to damp coke further than that in most foundries the coke was left out in the open in all weathers, but he had never noticed any difference as between a wet and a dry day. He could not, however, give a definite intelligent opinion on the point. With regard to success or otherwise with a larger cupola and heavier scrap, it would be out of place to take it upon himself to say that he had melted heavier iron with the same ratio as he had demonstrated that afternoon. He left that to others who had had the experience. They might not care to accept his statement, and he did not wish to force it down anyone's throat if he had any doubt about it. As to blowers and fans, he agreed with the suggestion that with a positive blower they were more certain of getting a positive blast, but in this connection he recounted an experience he had had in a malleable iron foundry, where they were melting in an ordinary cupola. Those who had had experience of malleable iron knew that either in the pig or in the scrap, malleable iron was mostly of a smaller nature than ordinary grey iron. Consequently, when put into the cupola it would pack more closely. He had been called in to give advice under such circumstances. They had a positive blower, and were getting a good pressure, but the scrap was so small that the pieces packed so closely that it was impossible to force the blast through. When the blast was put on at first the pressure was normal, because the tapping hole was open. When that was blocked the pressure on the gauge jumped to double what it was before, and they thought they were getting plenty of blast and volume, and they could not understand why they were not melting. When they opened the slag hole the pressure dropped, which demonstrated that if they did not get the blast through the material and up the stack they could not melt successfully. Sometimes the belting would slip or the belt come off, but there was a chance of a blower overcoming a certain amount of resistance, whereas they would not have that trouble with a fan. His experience, both here and in the United States, was that if they had a suitable and well-constructed fan, properly fitted together, satisfactory results could be obtained. He had used a blower on one occasion which was British made; when new it had worked splendidly, but it was set up in a room in which there was a gas engine, and after about a week it began to lose pressure, and he could not get the iron melted. On one occasion they had to stop blowing and pull the material out of the cupola. When he took the top off the blower he had found that the plates had been plastered with plumbago and tallow to make them fit the casing, and when it was installed in the hot engine room the heat had melted the tallow, and between the casing and the plates he could put his fingers down. As he had said, with a *properly constructed* fan—he had seen nearly 100 tons melted in one run with a fan—he was satisfied that the work could be done pretty nearly as well as with a positive blower, and if they had to have belt driving he would say use a positive blower. With regard to iron bricks, he had seen them used successfully. The only fault he had found was that if they were used for very severe work there was a tendency to vibrate loose and fall out. Much had been said with regard to the class of iron used to-day, and again, referring to the visit to his works, he reminded them that the cupola there was not working under normal conditions. There were only four tuyeres in service that day, the top row having been blocked up to reduce the depth of the bed charge. Probably the metal was not so hot as some of them would have liked to have seen it, but it was not usual to put much pig-iron into brake-block castings. They had to pay more for pig-iron than for scrap, and as his lecture was on economical lines, he had been working his cupola economically that day. Something had also been said on the question of the proportion of the bed charge consumed. He had been asked on the charging stage that day whether he had found the returned coke working satisfactorily, and those on the stage would have noticed that he mixed in the returned coke from the previous blow with the other coke. They were not using best Welsh coke that afternoon, which was another thing not in their favour; it was ordinary Durham. Normally ⅔ths of the coke bed was

recovered. He had also had that experience in other places where he had used larger cupolas, and there were gentlemen present who could confirm his statement. As to the carbon monoxide and the spiral tuyeres, he had tried to make it clear at the beginning that the rank and file in the foundry trade knew very little about carbon monoxide, and his object was to try to get something into their minds, to say something useful to the rank and file, and in such language that they could understand. He again expressed his thanks to those who had criticised his remarks, and expressed his willingness to carry the matter further on a future occasion.

The President, speaking with regard to the difference in the results obtained with coke on a wet and a dry day, said he had noticed a great deal of difference with both natural draught furnaces and cupolas

Mr. A. R. Bartlett moved a vote of thanks to Mr. McClelland, both for his interesting lecture and for the reception he had accorded the members at his works that afternoon. This was seconded by Mr. Wilton.

Company News.

Ransomes, Sims & Jefferies, Limited.—No dividend on preference shares.

Cammell, Laird & Company, Limited. — Ordinary dividend, 5 per cent. for year, less tax; carry forward, £38,637.

Welsteads, Limited.—Capital £1,000 in £1 shares. Engineers. Directors: C. F. Welstead and Agnes Welstead. Registered office: 27, New Road, Richmond.

Dalgetti Electric, Limited. — Capital £500 in £1 shares. Directors: W. E. L. Bury, R. H. Limming, and J. G. White. Registered office: 10, Conduit Street, W.

Cole & Perks, Limited.—Capital £1,000. Brass and iron founders, etc. Life directors: D. Cole and G. Perks. Registered office: Sams Lane, West Bromwich.

British Metal Corporation, Limited. — Profit, £69,675; brought forward, £6,774; available, £76,449; dividend, 7 per cent., less tax; carry forward, £11,979.

Edward C. Barlow & Sons, Limited. — Capital £100,000 in £1 shares. Engineers, etc. Life director: E. C. Barlow. Chairman: E. E. Barlow and R. Barlow.

Cooper Upton, Limited.—Capital £1,000 in 700 ordinary shares of £1, and 1,200 founders' shares of 5s. General engineers. Registered office: 6, Fen Court, Fenchurch Street, E.C.

Webb & Wilson, Limited.—Capital £1,000. Constructional and mechanical engineers, etc. Directors: G. L. Wilson and H. E. Webb. Registered office: 523, High Road, Tottenham, N.17.

Engineering Developments, Limited.—Capital £500 in £1 shares. Ironfounders, etc. Directors: F. E. Saunders and P. Buckley. Secretary: E. Hunt. Registered office: 60, Chandos Street, W.C.2.

Robey & Company, Limited.—Profit, £26,976; depreciation, £10,169; brought forward, £36,447; dividends, 2½ per cent., less tax, on preference and ordinary; provident fund for employés, £1,000; carry forward, £26,517.

British Aluminium Company, Limited.—Profit, including amount brought forward, £82,817; depreciation, £20,000; reserve, £10,000; final ordinary dividend, 5 per cent. per annum, making 5 per cent. for year; carry forward, £14,791.

Scottish Tube Company, Limited.—Profit, £10,000; brought forward, £20,341; interest on debenture stock, £3,767; redemption of debenture stock, £11,232; depreciation, £3,767; available, £71,705; reserve, £15,000; ordinary dividend, 7 per cent., less tax; carry forward, £19,054.

Emptying Oil Barrels by Compressed Air.—A recent issue of "Power" describes a device for emptying barrels of oil by compressed air. With a 4-lb. pressure a barrel of engine oil could be emptied in seven minutes, forcing the oil to an elevation of 8 ft. A dead-weight safety valve was made by turning the threads off the stem of a ⅜-in. angle valve and securing sufficient weight to the valve wheel to balance a 4-lb. pressure. The valve was placed in the air line between the barrel and the air supply valve, which, for ease of control, should not be larger than ¼ in. The small opening of a ¼-in. valve was sufficient to elevate the oil rapidly. The ordinary oil barrel will safely withstand 4-lb. pressure. When the oil is all out of the barrel, the slight blow of air through the discharge pipe will indicate it.

Gazette.

The Alliance Die Castings Company (Coventry), Limited, are being wound up voluntarily, with Mr. T. W. Daffern, Economic Chambers, Little Park Street, Coventry, as liquidator.

Messrs. J. Radcliffe and W. L. Roberts, engineers' pattern-makers, trading under the style of the Standard Pattern Company, Cobden Street, Pendleton, Salford, have dissolved partnership.

Messrs. J. E. Rollinson and E. J. Greensmith, electrical engineers, Tavistock Chambers, Beastmarket Hill, Nottingham, trading under the style of Rollinson & Greensmith, have dissolved partnership.

At the expiration of three months the names of the undermentioned companies will be struck off the Register of Joint Stock Companies, and will be dissolved:—Anglo-Burmah Wolfram Syndicate, Limited, Bright's Light and Power, Limited, British Engineering Company (London), Limited, Cardiff Docks Engineering Works, Limited, Heard's Welding Syndicate, Limited, Productive Engineers, Limited, and Yarwood & Company (Novelty Ironworks), Limited.

Personal.

The late Mr. J. Wootton, engineer and ironfounder, managing director of Wootton Bros, Limited, left £37,068.

The late Mr. J. C. Glegg, managing director of Glegg & Thomson, Limited, and a director of the Aberdeen Electrical Engineering Company, Limited, left £96,141.

Mr. W. D. Robinson, manager of the Export Department of the Chicago Bridge and Ironworks and the Horton Steelworks, Limited, is on a visit to the leading centres of South Africa.

Mr. W O. Wallis, a director of Arthur Shaw & Company, Limited, lockmakers, brassfounders, etc., Willenhall, Staffs, and one of the founders of the Shaw Foundry Company, who died on December 16, left £68,035.

Mr. E. Hopkins has been placed in charge of the export iron and steel department to India, Australia and the East, of Ironside, Son & Company, 32, Grosvenor Place, London, S.W. He was formerly general manager of the London branch of Dutton, Massey & Company, of Liverpool.

Mr. E. M. Griffiths has resigned his position as a director of the Birmingham Small Arms Company, Limited, and also that of chairman and director of Burton, Griffiths & Company, Limited. He is retaining his office at 30-32, Ludgate Hill, E.C.4.

Mr. W. F. Piper, representative of Messrs. Beardesley & Piper, Inc., manufacturers of foundry machinery, 312, Union Park Court, Chicago, is visiting the chief centres of industry in Europe, and during his stay his address will be c/o Harold Sharpe, Foundry Plant and Machinery Company, 28, Exchange Square, Glasgow.

Deaths.

Mr. A. Giles, of F. Giles & Sons, brassfounders, Birmingham, died recently.

Mr. F. T. Shaw, of W. Shaw & Company, steelfounders, Middlesbrough, died recently in his forty-seventh year.

Mr. J. Marshall, of Marshall, Fleming & Company, Limited, Motherwell, manufacturers of steelworks cranes, died recently.

Mr. G. J. Williams, head of the Birmingham firm of Williams Bros. & Piggott, Limited, metal manufacturers, died recently.

Mr. J. L. Farmiloe, of T. & W. Farmiloe, Limited, lead-pipe manufacturers, Rochester Row, Westminster, London, S.W.1, died recently.

Mr. W. Lupton, J.P., head of the firm of Lupton Bros., Limited, brassfounders, Accrington, died on March 12. He was a vice-president of the Blackburn Chamber of Commerce.

Mr. William Cotterill, of Chatworth, Slatey Street, Darlaston, who for a number of years had been chief engineer to Messrs. Etchells, of the Bullpiece Works, Darlaston, died suddenly on Saturday last at the age of 56 years.

Mr. J. M. Draper, of Queen's Avenue, Porthcawl, died suddenly recently. He was a director of the Rhondda Engineering and Mining Company, Limited, the Manchester Minerals Tributes, Limited, and Sheppard & Sons, Limited.

Mr. John Green, who died on Thursday, the 16th inst., at Pedmore, near Stourbridge, where he had resided for many years, was one of the pioneers in the anchor and cable trade in the Old Hill district. He founded a business there about 50 years ago, and only retired from active association with it when about 50 years old.

IRON AND STEEL MARKETS.

Pig-iron.

The uncertain conditions now prevailing in the industrial world have had a decidedly adverse effect upon pig-iron markets, in which there has been a distinct falling off in demand during the past week. This is specialy noticeable in the case of a foundry iron, inquiries for this quality showing a decrease in volume, while the limited production for the time being is apparently equal to trade requirements. In the Glasgow market values indicate some weakening consequent upon the partial stoppage of the engineering works, prices having given way to the extent of 2s. 6d. per ton in most of the leading makes. There is keen competition for any orders for Scotch iron, however small, coming into the market, and producers are said to be doing the bulk of their business with very little, if any, margin of profit. Reports from South Staffordshire pig-iron smelters are much the same as their northern contemporaries, nor is any improvement expected until production costs are reduced. The announcement of the prospective closing of the Tees Bridge Ironworks, Stockton, has been received with consternation in the Cleveland district, as evidencing the recent decline in demand, partly owing, it may be assumed, to the competition of Midland furnaces, as both Derbyshire and Northamptonshire makers are offering at substantially lower rates. Business at Middlesbrough has consequently been on a restricted scale, as far as home consumption is concerned, but a fairly good export trade is reported with shipments up to date comparing favourably with the March returns. At present No. 1 and silicious iron are only obtainable in microscopic quantities, but other qualities can be more easily bought for prompt or forward delivery. The "official" prices are as follows:—No. 1 and silicious, 95s.; No. 3 Cleveland, G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d.; mottled and white, 80s. per ton, either for home consumption or export.

Conditions in the East Coast hematite market are also quieter than has been the rule of late, buyers hesitating to commit themselves, in view of the uncertainty of the position. Italy, too, is not buying just now, although there are still a few inquiries. Some good sales have, however, been made to Germany, despite the further depreciation of the mark, and other inquiries are in the market. Still, on the whole, the hematite trade is not so brisk, and makers, though quoting 100s. for mixed numbers and 101s. for No. 1, might possibly shade these figures for suitable business. West Coast hematite is again unchanged, quotations for Bessemer mixed numbers ruling at 98s. 6d. per ton at works, and ferro-manganese at £15 per ton.

Finished Iron.

Last week's Birmingham market for finished iron disclosed little improvement from the manufacturers' point of view, even the marked bar houses, usually the most stable branch of the trade, beginning to feel the general depression. Makers most affected, however, are firms producing normally good class crown and special quality irons, some of whose mills have been standing idle for months for the reason that production was unprofitable at the current price of £11 10s. Nut and bolt iron is now quoted at £10 10s., and fencing bars at £10 12s. 6d., competition for orders in these lines being very keen. Special irons, such as cable and gas strip qualities, are in poor demand, makers in these branches being unable to meet the competition of steel makers, which has been recently augmented by the erection of new mills in the Black Country and other districts. Similar conditions apply in the case of makers of finished iron in Yorkshire, where business is also depressed, crown bars at £12 f.o.t. not attracting much attention, neither do hoops, the price of which is £14. Swedish bar iron is £20, just a third what it was during the war. Very few foundries are actively employed, and with even a temporary stoppage of the engineering industry business in castings must necessarily be on a restricted scale.

Steel.

Movements in the steel markets present few fresh features at the moment, the uncertain outcome of the engineering dispute having had a depressing effect upon most of the manufacturing branches of the trade. This is specially applicable in connection with the steel foundries, which are largely dependent upon orders for engineers' castings for both marine and general departments to keep works going. Billet production, both acid and basic, is fully equal to present requirements, if not in excess, but prices are unchanged, though it is reported that some Siemens acids are being sold at £10, which is a pound under the regular market quotation. Bessemers hold at £12 10s. Swedish Bessemer billets are quoted at about £25. There are, however, no foreign imports of acid semi-products at the present time, but some competition from the North-West Coast, from whence local makers have been sending the material into Sheffield at £10 per ton. The production of steel ingots and castings in February amounted to 415,000 tons, compared with 327,000 tons in January.

Scrap.

Buying in the scrap metal markets generally has been reduced of late to very small proportions, and there are few signs anywhere of renewed activity of demand In the Tees-side market only a few parcels of steel scrap have been disposed of during the past week, and the price ruling for a small specification has been 62s. 6d., and for ordinary specification 60s., both delivered works. Moderate sales of steel turnings and c.i. borings are reported at 42s. 6d. per ton delivered, with ordinary heavy wrought-iron piling scrap nominal at about 65s. delivered, and heavy forge iron also nominal at 70s. per ton. There is only a small demand for heavy cast-iron machinery scrap at 82s. 6d. to 87s. 6d. delivered, and ordinary heavy cast iron in handy pieces is quoted at about 80s. delivered.

Tinplates.

Conditions in the tinplate market, although showing a firmer tendency, reflect little improvement in buying, demand remaining as hitherto on the quiet side, with prices steady as follow:—I C 14 x 20 and 28 x 20.—Cokes are realising 19s. and 38s. respectively. For April-May, quotations run:—I C 14 x 20, 112 sheets, 108 lbs., 18s. 9d. to 19s. per box; I C 28 x 20, 112 sheets, 216 lbs., 37s. 6d. to 38s. per box; f.o.b. Wales. Coke wasters are in better demand of late, with quotations firm, as follows:—C W 14 x 20, 112 sheets, 103 lbs., 16s. 9d. to 17s. per box; C W 28 x 20, 112 sheets, 216 lbs., 33s. 9d. to 34s. per box; C W 14 x 18¾, 124 sheets, 110 lbs., 18s. to 18s. 3d. per box; C W 20 x 10, 225 sheets, 156 lbs., 22s. to 22s. 3d. per box; all f.o.b. Wales.

Metals.

Copper.—Markets for this metal opened the week's business with a somewhat steadier tone, and with some fairly good buying on forward account values for three months appreciated to a fractional extent. Prices, however, of standard copper are now influenced largely by the fluctuations of the American exchange, and with the prospect of a re-opening of the mines, there has been a fair amount of speculative selling. March dates were done at £58; April, £57 15s. to £58 8s. 9d.; while electrolytic qualities declined 5s. to £64 5s to £65 15s., with wire bars at similar values:—Closing prices:—Cash: Wednesday, £58 5s.; Thursday, £58 5s.; Friday, £57 12s. 6d.; Monday, £58 2s. 6d.; Tuesday, £58. Three Months: Wednesday, £59 2s. 6d.; Thursday, £59 2s. 6d.; Friday, £58 10s.; Monday, £59; Tuesday, £58 17s. 6d.

Tin.—More favourable advices from the East had little effect upon the market this side, which opened this week with an easy tendency. Unfortunately the conditions of the Welsh tinplate industry remain unsatisfactory, and consumptive demand is generally restricted to hand-to-mouth buying. Movements have been chiefly confined to freer offerings of forward metal, which were, however, in excess of requirements, with some weakening of values as a result. March deliveries were done at £143 5s.; April, £144 5s.; while English ingots closed lower at £142 15s. Stocks of tin in London warehouses show an increase of 177 tons on the week, to 4,909 tons, with Liverpool stocks 20 tons down at 1,829 tons. Closing prices:—Cash: Wednesday, £143 7s. 6d.; Thursday, £144 5s.; Friday, £144 7s. 6d.; Monday, £143 12s. 6d.; Tuesday, £142 12s. 6d. Three Months: Wednesday, £144 17s. 6d.; Thursday, £145 15s.; Friday, £145 17s. 6d.; Monday, £145 2s. 6d.; Tuesday, £144 5s.

Spelter.—There was only a quiet inquiry in the market for this metal, sales being confined to June delivery, which were transacted at £25 7s. 6d., a slight reduction on last week's quotation. Closing prices:—Ordinary brands: Wednesday, £26 10s.; Thursday, £25 10s.; Friday, £25 12s. 6d.; Monday, £25 12s. 6d.; Tuesday, £25 15s.

Lead.—The tendency in the market for soft foreign pig continues steady, sellers offering sparingly, and values having a firmer tone, both near and forward dates closing with a small advance. English lead also improved, and is dearer. English closing prices: Wednesday, £22 15s.; Thursday, £22 10s.; Friday, £22 10s.; Monday, £23; Tuesday, £23 5s.

XUM

Trade Talk.

Salterns, Limited, propose building new wharves and docks at their Salterns Works, Parkstone.

Smith, Roberts & Company have established themselves in business as engineers at Horsmonden, Kent.

Mr. W. R. Barclay gave an interesting paper on "Some Nickel Alloys" to the Sheffield Section of the Institute of Metals recently.

Electric Control, Limited, announce that after April 1 their London office address will be Hastings House, Norfolk Street, Strand, W.C.2.

Alldays & Onions, Limited, Great Western Works, Birmingham, have received the contract for the supply of foundry plant to the L.C.C. Central Car Repair Depôt.

Hickman Batchelor & Company, Limited, iron, steel and machinery agents, 87, Borough, London, S.E.1, removed on March 25 to 34, Crutched Friars, E.C.3.

Mr. W. N. Turner, 9, Shaa Road, Acton, London, W.3, has been appointed London and Birmingham representative of Centrifugal Castings, Limited, Kirkstyle Road, Kilmarnock.

The Belfast Water Commissioners have placed the contract with S. Pearson & Son, Limited, for the construction of their new reservoir and dam at the Silent Valley, Co. Down.

Before the members of the Sheffield Society of Engineers and Metallurgists recently, Dr. W. H. Hatfield, of the Brown-Firth Research Laboratory, delivered an interesting lecture on "The Mechanical Properties of Steel."

The Hodbarrow Mining Company, Limited, of Millom, have succeeded in having the assessment of the mines for Poor Law valuation reduced from £110,000 to £20,000. The mines have been idle almost throughout the last twelve months.

The operation of the following Australian Customs duties have been postponed: Metal cordage, until June 30; hoop iron and steel, plain and tinned iron and steel plates, sheet steel and iron, steel tubes not exceeding three inches in diameter, until September 30.

The wagon builders' dispute at Cardiff has been settled after lasting a month, the terms having been mutually agreed upon. The proposal of a 25 per cent. cut in wages has been agreed to by the men accepting a reduction of 15 per cent., with the other 10 per cent. to remain in abeyance for a while.

Mr. William Clark, J.P., managing director, of Vickers, Limited, will occupy the chair, and Mr. John Hall, of Hall & Pickles, Manchester, the vice-chair, at the seventy-fourth anniversary festival banquet of the Royal Metal Trades' Pension Society, to be held in the Hall of the Worshipful Company of Cutlers, on Tuesday, May 30.

G. A. Harvey & Company (London), Limited, Woolwich Road, London, S.E.7, will exhibit their ventilators, chimneys, perforated metals, steel equipment, etc., at the Building Trades Exhibition at Olympia from April 11 to 27. Ransome Machinery Company (1920), Limited, propose exhibiting concrete mixing machinery, tar macadam and asphalt plant, steel piling and piling plant, etc.

The International Construction Company, Limited, 56, Kingsway, London, W.C.2, inform us that Taylor Bros. & Company, Limited, Manchester, have recently placed an order with them for a Morgan gas producer machine, which now makes the 56th installation in Great Britain, out of which, in spite of trade depression, 12 have been placed during the last eight months.

The opening of the tenders for the supply to the Calcutta Corporation of about 14,000 tons of steel piping in connection with the waterworks extension took place on March 16. The lowest five tenders were British, then came an Indian tender, and one from the United States. The lowest was found to be that of the Cleveland Bridge & Engineering Company, Limited, of Darlington. The quotations ranged from £300,000 to £480,000.

The Federation of Leather Belting Manufacturers of the United Kingdom, Great Grimsby Coal, Salt and Tanning Company, Limited, Browett, Lindley & Company, Limited, A. C. Potter & Company, Ansell, Jones & Company, Limited, Phipson & Warden, Limited, G. & B. Morvan, Limited, Leedham & Heaton, Limited, Eagle Engineering Company, Limited, Penman & Company, Limited, and Isaac Griffiths & Sons have joined the Federation of British Industries.

The Shipbuilding Employers' Federation at their meeting at Edinburgh last week decided to adhere to the terms of their revised offer made to the Trade Unions in the negotiations of the previous week, and to post notices of a first reduction of 10s. 6d. per week to take effect on March 29, and a second reduction of 10s. per week on April 26. Thus the concessions upon the original proposal made to the Trade Unions in the interest of industrial peace continue operative if the workmen choose to accept them.

Mines de Manganese D'Ouro-Preto, a Belgian concern, reports profits aggregating 1,630.535 fcs. (£65,221 at par) for the financial year 1920-1921, as against 1,970,427 fcs. (£78,817) in the previous year. The Company's manganese mines in Brazil are completely exhausted and mining there has entirely ceased. As no other manganese mine of any size could be found in that country the Company have cleared their stocks and closed the Brazil branch of their undertaking. The Company has ceded their interest in the Georgia mines to the Société d'Exploitations Minières, in which the Ouro-Preto Company holds shares.

Mr. William Clark, managing director of Vickers, Limited, was last week elected president of the Sheffield Chamber of Commerce in succession to Mr. S. J. Robinson. In his speech acknowledging his appointment to the office, Mr. Clark said there was a strong likelihood of considerable orders being placed with this country from one of her Allies. Practically every industrial centre would benefit. It transpires that the orders referred to are for railway material and locomotives for Rumania. Financial considerations have operated against the placing of orders for some months, and it is understood that these have now been satisfactorily overcome. The first of the orders will be for a large number of locomotives.

Continuing the course of lectures on foundry practice recently arranged by the University of Sheffield, Dr. Longmuir dealt specifically with "wasters" in brass, bronze, cast iron and steel. Taking first the condition of the mould to receive the molten metal or alloy, fundamental principles were considered in relation to green sand, dry sand and loam moulds. The mould and its cores must always be in a condition to resist the searching action of the fluid metal or alloy; further, to resist fusion, and, finally, it must allow the free escape of air and mould gases. Determining conditions to meet these most essential features were indicated for the various metals and alloys. Taking in the second place the condition of the molten metal, Dr. Longmuir dealt with the various possibilities of failure due to faulty state of metal, or alloy when poured into the mould. The next lecture will be given by Dr. Hatfield on malleable cast-iron.

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